

New England Estuarine Research Society

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MEETING ABSTRACTS

NEW ENGLAND ESTUARINE RESEARCH SOCIETY

AND

JACKSON ESTUARINE LABORATORY 25TH ANNIVERSARY RETROSPECTIVE

Spring Meeting, April 27-29, 1995

**Yoken's Comfort Inn Conference Center
Portsmouth, New Hampshire**

AND

**Jackson Estuarine Laboratory
Durham, New Hampshire**

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Beatty, Lynn L. and Candace A. Oviatt. Graduate School of Oceanography, University of Rhode Island, Narragansett, R.I. 02882. THE USEFULNESS OF ENCLOSURE EXPERIMENTS IN THE STUDY OF THE ECOLOGICAL EFFECTS OF CONTAMINANTS ON MARINE SYSTEMS

Classically, single species laboratory toxicity tests have been used to predict the effects of contaminants on marine ecosystems. While these exposure-response data are important, it is often difficult to extrapolate results to natural communities with complex interactions such as competition and predation. Experiments in multispecies test systems such as mesocosms are valuable because they provide information on both direct and indirect effects of contaminants on community and ecosystem level parameters. There are also advantages to mesocosm experiments over field studies; for instance, multiple enclosures allow a gradient of exposure or dose to be established and controlled to a degree not possible in the coastal environment.

Since 1976, experiments have been conducted in outdoor enclosures situated on the coast of Narragansett Bay at the University of Rhode Island. A number of studies have examined the fate and effects of complex mixtures on the coastal ecosystem with results that would not have been predicted from single species tests because of the ways in which interactions between ecosystem components affected results, often in unpredictable ways. During a series of No. 2 fuel oil studies, much of the added oil quickly settled to the bottom sediment and the impact on benthic fauna was particularly severe and long-lasting while changes brought about in the water column were less dramatic and rapidly ameliorated after oil additions ended. In a sewage sludge experiment, organisms responded to the carbon in the sludge as a food source; although there was no apparent toxicity due to organics or metals, prolonged hypoxia and even anoxia occurred in the upper treatment levels which had important ramifications for the various elements of the ecosystem.

Roelof M Boumans, Jackson Estuarine Laboratory, Durham, NH 03825
THE SEDIMENT EROSION TABLE (SET) MEASUREMENT, AN INTEGRATED RESPONSE OF THE COASTAL AREAS TO WIDE-RANGING ENVIRONMENTAL FORCING.

Stress on natural resources, in particular coastal environments, increases worldwide. This calls for standardized and integrative measures that allow us to assess impacts easily. The SET method is a repeatable, easily to use technique that in recent years has gained wide application. For example this year SET stations will be implemented to monitor eelgrass beds and salt marshes in the Great Bay area. It measures net change in sediment elevation of the subsurface (δE). δE integrates a host of ecosystem-level processes that are critical to landscape pattern and processes, for example sedimentation, erosion, belowground productivity and change in sediment level.

The SET was originally developed to study the intertidal mudflats impacted by the Ooster Schelde locks (the Netherlands). Later it was modified for the Louisiana coastal zone to study landloss processes and the success of wetland restoration. data will be presented data on elevation increases resulting from marsh restoration using brush fences to enhance sedimentation. Brush fences placed in shallow water caused elevation increases of up to 2.5 cm per year. In addition data will be presented on elevation changes measured with the SET in a degrading marsh.

Marcia Bowen and Paul Geoghegan, Normandeau Associates, Yarmouth Maine and Bedford, New Hampshire.

EFFECTS OF THE RESUMPTION OF RECREATIONAL CLAMMING ON THE POPULATION OF *MYA ARENARIA* IN HAMPTON HARBOR, NEW HAMPSHIRE.

We have surveyed the clam population in Hampton Harbor annually since 1984 as part the Seabrook Station's environmental monitoring program. Several factors affect juvenile and adult densities including predation by green crabs, disease (neoplasia), and human predation in the form of recreational clamming. Clam flats were closed to clamming in April, 1989. Clam flat densities increased in subsequent years, but in what are apparently disease-free areas only. Clam flats were reopened in September 1994 and subjected to intense harvest activity. The effects of harvesting were not detected, as densities of adult clams in 1994 on a flat-wide basis were similar to densities in 1993. Effects of recreational clamming may only become apparent after several years of the cumulative removal of adult clams in combination with the related mortality resulting from disturbance of undersized clams.

Mike Connor, Mass Water Resources Authority, Boston, MA 02129
USING MONITORING DATA TO TRIGGER MANAGEMENT DECISIONS: MWRA'S CONTINGENCY PLAN FOR DISCHARGING SECONDARY EFFLUENT TO MASS BAY.

MWRA and the agencies regulating it have proposed a unique linkage of management actions depending on monitoring results. As part of its Biological Opinion for the MWRA NPDES discharge of secondary effluent to Massachusetts Bay, the National Marine Fisheries Service (NMFS) required MWRA to develop a Contingency Plan in case MWRA's monitoring program detected unanticipated problems associated with the discharge. The Contingency Plan identifies relevant water quality issues, establishes water quality indicators of environmental health, determines quantitative and qualitative levels of those indicators that would "trigger" MWRA to conduct further actions or initiate remedial responses, and identifies applicable responses, including appropriate changes in operations and maintenance at its Deer Island treatment plant.

Crossin, Glenn T., Saud Abdulazziz Al-Ayoub, W. Huntting Howell & Winsor H. Watson III. Zoology Department, University of New Hampshire, Durham, NH 03824

THE EFFECTS OF TEMPERATURE ON LOBSTER (*HOMARUS AMERICANUS*) BEHAVIOR

It is generally accepted that lobsters (*Homarus americanus*) sense and respond to water temperature. However, little documentation of the effects of temperature on lobster behavior exists. To quantify the effects of temperature, three experiments were conducted at the University of New Hampshire's Coastal Marine Lab. In the first experiment, lobsters were placed in temperature controlled shelters and the temperature inside was gradually raised. Data collected over the summer of 1994 indicated that lobsters found 20° to 23°C aversive and left the shelter. The ambient temperature was 15° to 18°C, representing an average increase of 6.5°C. A second experiment gave lobsters a choice between five shelters, two set at temperatures above the ambient, two set below, and one held at the ambient (11°C). Lobsters consistently chose the shelter just slightly above ambient. The final experiment used drops in heart rate as an indication that lobsters sensed a change in temperature. In preliminary studies, lobsters exhibited bradycardia in response to small (<5°C), rapid increases in temperature. More experiments are needed to determine how small a change they can sense, and further temperature preference experiments need to be conducted using cooler ambient temperatures.

Davis, Ryan and Frederick T. Short. Department of Natural Resources, Jackson Estuarine Laboratory, University of New Hampshire. Durham, NH 03824 MORPHOLOGICAL ADAPTATIONS OF TRANSPLANTED EELGRASS (*Zostera marina* L.)

Eelgrass was transplanted at five subtidal sites in the Piscataqua River, New Hampshire in 1993 and 1994. The donor site for the transplants was a large intertidal bed with relatively narrow, short-leaved eelgrass. Naturally occurring eelgrass beds in the estuary, which were used as controls, grow in subtidal areas. The plants from these beds were found to have significantly longer and wider leaves than plants from the donor site. Monitoring of the transplants showed that the mean leaf length and mean leaf width of the transplanted eelgrass increased over a two year period to more closely match those of the naturally occurring eelgrass populations in the immediate vicinity of the transplants. The morphology of eelgrass leaves is therefore a phenotypic characteristic which can show changes within one growing season in adaptation to new environmental conditions.

Chris Dufort, Glen Crossin, Hunt Howell & Win Watson, Zoology Dept. & Center for Marine Biology, Univ. of New Hampshire, Durham, NH 03824 THE USE OF BRADYCARDIA AS AN INDICATOR THAT LOBSTERS CAN SENSE CHANGES IN SALINITY.

The American lobster (*Homarus americanus*) is a common inhabitant of New England bays and estuaries, where large fluctuations in salinity are common. Previous studies in our laboratory demonstrated that lobsters find low salinity water aversive (Jury et al., JEMBE 180: 23-37, 1994). In this study our goal was to use a physiological, rather than behavioral, assay to determine: 1) the minimum drop in salinity they can detect; 2) whether they sensed ions or osmolarity and; 3) what region of the body contained the salinity receptors. The indicator used to determine if they detected a change in salinity, was a sudden drop in heart rate, or bradycardia. Using this assay we found that lobsters are able to sense changes in salinity as low as 5 ppt. We also found that females, on average, are more sensitive than males (females respond to drops from 32-23.5 ppt and males drops from 32-19.5 ppt). This male:female difference is consistent with previous behavioral observations. Our preliminary data suggests that lobsters are sensing changes in the concentration of chloride ions and while the legs and antennules may contain receptors that contribute to the response the primary receptors are located elsewhere, most likely in the branchial chamber.

Charles N. Farris, University of Rhode Island, Graduate School of Oceanography/National Park Service, Narragansett, RI 02882-1197. SEASONALITY IN OXYGEN EXCHANGE RATES OF TWO SUBTIDAL MARSH BASIN HABITATS.

Seasonal changes in oxygen levels in estuarine systems are strongly influenced by variations in oxygen demand of subtidal sediment habitats. Field incubation experiments were conducted from spring to fall to measure the oxygen demand in two subtidal marsh habitats: sediment beds and macroalgal mats. These were run at three salinity levels in the presence and absence of light. Significant differences were found between light and dark treatments, as well as between sediment incubation treatments and macroalgal incubation treatments. Light macroalgal oxygen exchange rates had maximum levels (up to $1438 \text{ mg O}_2 \text{ m}^{-2} \text{ h}^{-1}$) in the mid-summer runs and were five to ten times the size of sediment oxygen exchange rates. The dark macroalgal oxygen exchange rates were nearly as large (up to $-577 \text{ mg O}_2 \text{ m}^{-2} \text{ h}^{-1}$) and were comparably larger than dark sediment oxygen exchange rates. The salinity incubation runs showed significant differences between the low salinity level and the two higher levels, implying an inhibition of oxygen exchange processes in the marsh basin at low salinity (0 - 3 p.s.u.) levels. These experiments imply oxygen - exchange rates of subtidal marsh habitats are driven by the presence of macroalgal mats, day/night differences and intrusion of low salinity waters.

Bernie Gardner, Environmental Sciences Program, University of Massachusetts/Boston, 100 Morrissey Blvd., Boston, MA 02061, gardner@umbsky.cc.umb.edu. NEERS ON INTERNET

The growing availability and sophistication of access to the INTERNET provide an opportunity for the scattered members of NEERS to enjoy increased communication and cooperation. I have made an attempt at facilitating this by E-mailing a list of known addresses to, well, people whose addresses were known to me. I have also set up a LISTSERV mailing list at UMASS/Boston which allows for simple distribution of mail to people who sign up for the list. I will describe both of these briefly, and hopefully add to the list of known addresses. I also plan to discuss additional electronic communication possibilities, including newsgroups and a NEERS World Wide Web home page. I am just learning about most of these things myself, and hope to get input from anyone who has found other routes on the information highway.

Robert Garritt and Linda Deegan, Ecosystems Center, Marine Biological Lab, Woods Hole, MA 02543
CARBON, NITROGEN AND SULFUR ISOTOPES AS TRACERS OF ORGANIC MATTER FLOW IN THE PLUM ISLAND SOUND ESTUARY, MASSACHUSETTS.

Carbon, nitrogen and sulfur stable isotopes were used to determine the importance of algal production, saltmarsh and terrestrial organic matter sources to the food web of Plum Island Sound. Upstream in the upper bay site, salinity varied from 0-16 ppt. with primary and secondary consumers reflecting mixtures of terrestrial, freshmarsh, saltmarsh and algal derived organic matter. Carbon and sulfur isotopic signatures of primary and secondary consumers in the saltmarsh and lower bay sites (19-31 ppt.) suggest *Spartina* and algal organic matter are equally important. Terrestrial organic matter was not detected in consumers from the saltmarsh and lower bay sites. Locally produced organic matter appears to be locally consumed.

Eric Holt, Eric Strauss and Solange Brault, Department of Biology, The University of Massachusetts, at Boston, Boston, MA 02125
DETERMINANTS OF SHARP-TAILED SPARROW (*Ammodramus caudacutus*)
DISTRIBUTIONS ON CAPE COD

We tested the reliability of using salt marsh graminoid percent cover, and the availability of exposed mud for foraging, as predictors of Sharp-tailed sparrow abundance on 11 marshes on Cape Cod. In New England, flooding of the marsh surface occurs at least once a month, and is the major cause of nestling mortality. The frequency of that flooding is dependent on microtopography, and is indicated by changes in dominance between *Spartina alterniflora* and *S. patens*. These salt marsh graminoids can thus be expected to be a major predictor of Sharp-tailed sparrow abundance. We found that *S. patens* percent cover accounted for 60% of the variation in Sharp-tailed sparrow abundance when transects were viewed as a whole. However, when the three transects with the highest sparrow abundance are looked at separately the relationship which had been positive became negative. When each of these transects is looked at separately the presence of other important predictors is indicated. We expect an interaction between the vegetation and the availability of exposed mud to account for most of the unexplained variance. We are also currently testing the effect that marsh size and shape have on sparrow density.

William Hubbard, Coastal America Program (Northeast), US Army Corps of Engineers
MANAGEMENT DECISION MAKING AND THE VIEW OF COASTAL AMERICA

The Coastal America partnership is a national program that has focused the efforts of the 22 federal agency partners on priority coastal issues. There is a national office housed at the Council on Environmental Quality (CEQ). A principal team meets quarterly and is composed of Assistant-Secretary level agency directors. A National Implementation Team, composed of senior federal agency staff, meets monthly. There are 10 regional teams that coordinate the "on the ground" activities among each partner agency. The program is designed to identify priority actions in the areas of contaminated sediments, non-point source reduction and habitat restoration. These regional priorities are then discussed among the member agencies to determine if there is a member agency that has the existing authority to implement the proposed action. Those projects that requires the participation of several agencies to accomplish the goals are then endorsed as Coastal America actions. The regional and national teams have been working together to understand each others' programs and significant policy issues that interfere with the partnering of agency actions are identified for solutions at the principal team level. Nationally over 90 projects representing \$30 million dollars of collaborative efforts with hundreds of federal, state and nongovernmental agencies have been initiated.

In the northeast, several exciting projects are underway and more are anticipated. The best examples of success are the habitat restoration initiatives that are underway in New England. The NERIT has identified that the coastal saltmarshes of New England are often constricted from free tidal exchange. Many rivers are also blocked from free runs of anadromous fish into traditional spawning grounds. Regional interagency planning studies have been conducted or are underway to identify degraded salt marsh habitats. Once identified, the actual restoration of the sites is implemented under the authorities of the participating agencies.

Jeff Hughes, Institute of Marine and Coastal Sciences, Rutgers University, New Brunswick, NJ 08903-0231

EVIDENCE FOR ENHANCED CHEMOLITHOAUTOTROPHY IN RESUSPENDED SEDIMENTS FROM A SALT MARSH CREEK BED

Resuspension of surficial sediments from a salt marsh creek increased apparent carbon dioxide production by 40%, correcting for pore water flushing effects. Oxygen uptake, corrected for abiotic oxidations, was elevated 260% by sediment resuspension. The sedimentary respiration quotient ($\Delta\text{CO}_2/\Delta\text{O}_2$) averaged 0.84 in quiescent sediment and 0.30 in resuspended sediment. The large deficit of CO_2 produced relative to O_2 taken up suggests the enhancement of chemolithoautotrophy in the resuspended sediments.

Jack Kelly and Carl Albro, Battelle Ocean Sciences, Duxbury MA 02332

HIGH-RESOLUTION STUDIES OF WATER COLUMN PROPERTIES IN BOSTON HARBOR AND MASSACHUSETTS BAY

On twelve surveys spaced across each season in 1994, we conducted high-resolution studies in Massachusetts Bay using the Battelle Ocean Sampling System (BOSS). The BOSS is an array of *in situ* water-quality sensors, with data acquisition coupled to navigation, housed in a towfish that can be oscillated from near-surface to near-bottom at speeds up to about 7 kt. Primary studies concentrated on 1) the Boston Harbor — western Massachusetts Bay region, to characterize conditions where tidal exchange processes are active, and 2) an ~ 100-km triangle loop (Boston — Cape Ann — Stellwagen Bank — Boston), to characterize gradients of water quality at locations of significant water input to the Bay. The rich data sets collected along these transects allow vivid depiction of changing conditions with tidal ebb and flow near the Harbor, help resolve environmental questions regarding Harbor export to the Bay, and portray space scales of variability in ecologically-different regions of the Bay.

Arthur J. Libbey, Jr., Marine Sciences and Technology Center, The University of Connecticut, Avery Point, Groton, CT 06340-6097

The Import and Significance of Recent Advances in Analytical Chemistry to Marine Biologists.

Recent advances in trace metal speciation analysis enable analysts to identify and quantify metals in multiple oxidation states, as complexes, and in other forms at the ppb or even lower levels. The combination of sorbents for organics, such as polystyrene-divinylbenzene macroreticular resins, with continuous *in situ* water sampling permit the identification and quantification of organic compounds in complex matrices at levels, ppb or lower, hitherto impossible. This increased capability, however, demands greater attention to sampling, storage, and preservation of samples, if analytical integrity is to be maintained. Because of this, the analyst must be consulted at the outset of a project in which analytical chemical data is to be sought, and close communication be maintained throughout the duration of the project.

Long, C. D., and R. Zottoli, The Buffum Group, Salem, MA 01970 and Fitchburg State College, Fitchburg, MA 01420, ESTABLISHING THE DEVELOPMENTAL STAGES OF A POLYCHAETE (NEREIS RIISEI Grube, 1857--ANNELIDA:POLYCHAETA:NEREIDIDAE) FROM MUSEUM SPECIMENS.

Specimens taken during ecological surveys are sorted using a morphological "gestalt". Sorting accuracy is verified using standard identification techniques for the species on a small sample of the identified specimens. Due to the small mesh size used in current ecological surveys (in contrast to those of the 1800s and up to the mid-1900s), the samples may contain large numbers of juvenile polychaetes that lack the adult characters upon which this "gestalt" is based and are thus sorted as "spp. indeterminate".

Study of such specimens revealed the developmental stages expected (plus some unusual features) of the polychaete NEREIS RIISEI Grube, 1857. Since it is not commonly known that museum specimens can be used for establishing develop-

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DEVELOPING MEASURABLE GOALS FOR REDUCTIONS IN POLYCYCLIC AROMATIC
HYDROCARBON (PAH) LOADINGS TO BOSTON HARBOR SEDIMENTS

The Massachusetts Bays Program (MBP) is engaged in developing targets for environmental protection. Boston Harbor sediments have among the highest reported levels of organic contaminants, including PAHs, of all coastal sites in the U.S. PAHs in Boston Harbor derive from both point (treatment plant) and non-point sources of contamination. Current levels of PAHs are influenced by historical dumping of sludge, which ceased in 1991, and Metro Boston's large wastewater treatment plant, which will be relocated in 1997. This modeling exercise determined whether sediments would be measurably cleaner with reductions in PAH loads.

We employed EPA's WASP5 model to simulate the loadings, transport and sediment fluxes of high molecular weight PAHs to depositional areas in Boston Harbor. The model was informed by and calibrated to empirical measurements of water flow, sediment PAH and TOC concentration, particle deposition rates, PAH flux from sediments, and loadings from stormwater, rivers, atmospheric deposition, treatment plants and Massachusetts Bay. We determined the time, in years, for surface sediments to reach NOAA's ER-L level based on 25%, 50% or 100% reduction in loads from these sources.

In general, the most heavily contaminated segments, such as the Inner Harbor, will become significantly cleaner over 25 years, but not to ER-L levels. Reducing loads by 25% or 50% from stormwater, rivers or the wastewater treatment plant, does not appear to make an appreciable difference in the sediments becoming cleaner. Current loads are small in comparison to the existing inventory in the sediments. The cessation of sludge dumping appears to be responsible for sediments becoming cleaner. Surface sediments will become cleaner by a process of deposition of cleaner sediments, increased bioturbation and diffusion. The Inner Harbor is the most contaminated segment and the slowest to clean-up. Hingham Bay, is cleaner, but will slowly reach ER-L levels within 5 years.

The model appears to provide evidence that improved sediment quality in Boston Harbor can be attributed more to cessation of sludge dumping, and to a lesser extent, relocation of the Boston Harbor outfall, than to potential reductions in loadings from non-point sources. It would be worthwhile to test the hypotheses generated by the predictions of these models with an ongoing sediment quality monitoring effort tied to refined measurable goals incorporated into the Massachusetts Bays Program monitoring plan.

Rosemary Monahan and Katherine Metzger, US Environmental Protection Agency, JFK Federal Bldg., Boston, MA, 02203 and Maine Department of Environmental Protection, Station 17, Augusta, ME 04333.
NEW HAMPSHIRE RESOURCE PROTECTION APPROACH

The US Environmental Protection Agency has been testing a new approach to ensuring that we are targeting our efforts towards protecting New England's most important natural resources. We have been working with New Hampshire to develop a method for first identifying high priority resources in the state, and then working with others to protect them. We are using GIS as a tool, and working with partners from federal, state, and local agencies, environmental organizations, and business and landowner associations. The types of natural resources and their uses that we mapped included: habitats, water supplies, forestry, agriculture, and outdoor recreation. We also mapped pollution threats in the state. We have used the maps to identify areas where there are clusters of co-occurring resources, to assess the threats, and to pick areas where we can readily build partnerships for protection. We have identified 6 high priority natural resource areas in the state, including Great Bay and the Seacoast, and are now working to develop and implement protection plans.

Nancy J. O'Connor, Biology Department, University of Massachusetts Dartmouth,
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CRUSTACEAN BIOLOGY: FACTORS INFLUENCING SPAWNING AND THE SETTLEMENT AND METAMORPHOSIS OF LARVAE

Recently completed research focused on interactions between organisms responsible for fouling (coating the surface of) materials placed in seawater. Marine bacterial films affected the settlement of barnacle cyprid larvae, although whether settlement was enhanced or inhibited depended on the nature of the substratum to which the bacterial film was attached. Current research focuses on the influence of potential habitat cues (adult crabs and sediment particles) on the length of the last larval stage of fiddler crabs. Planktonic megalopae swim or sink to the seabed, and molt to a benthic crab stage. Soluble chemicals released by conspecific adults in seawater shortened the megalopal stage, but sediments alone or sediments exposed to adult crabs had little effect on megalopal duration. In additional research, an undergraduate student is examining factors that may increase off-season spawning in crabs, so larvae can be obtained and experiments performed year-round.

Judith Pederson, MIT Sea Grant College Program, Building E38-300, Cambridge, MA 02139

WALKING THE THIN LINE: A STATE PERSPECTIVE ON MANAGING COASTAL RESOURCES FOR THE FUTURE

As populations in coastal cities and towns increase, once "clean" embayments and estuaries are showing signs of increased pollution. Over the past few decades, pollution abatement efforts have resulted in reducing contaminant loads from point sources as they enter harbors and estuaries, but have achieved less success in reducing contamination from nonpoint sources. Attempts to improve regulations at all levels of government have resulted in overcontrol and undercontrol that are costly and may not achieve desired goals. Major projects often become mired in regulatory squabbles resulting in gridlock that may have environmental and economic costs which are unacceptable. Often disagreement about how stringently to apply regulations arise because scientific data are lacking. An integrated coastal management approach, i.e. a process that bring together all stakeholders and uses scientific data and information appropriate to the scale of the project, is gaining wide acceptance as a means of resolving conflicts and uncertainties. Specific projects, such as the Boston Harbor Navigation Improvement Project and New Bedford Harbor Wastewater Treatment Facility Outfall Siting will be used to illustrate where there is concurrence and differences in state, federal and local regulations and expectations of the public and where scientific input has helped to resolve the issues and bring diverse groups to a consensus on future actions.

Poitras, Christina A., Mark R. Fregeau, Alan M. Young, Biology Department,
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SEM STUDY OF HERMIT CRAB APPENDAGES

The longwrist hermit crab, *Pagurus longicarpus*, ranges along the western Atlantic coast from Minas Basin, Nova Scotia to Hutchinson Island, Florida. The species is found separately in the Gulf of Mexico from Sanibel Island to the Texas coast. Some morphological differences have been found in the longwrist hermit crabs between the Gulf of Mexico and the Atlantic coast populations. Using the scanning electron microscope (SEM), pictures of mouthparts and chelipeds of longwrist hermit crabs collected from two areas (Cape Cod and the Gulf Coast) may help to determine if these two populations are one species or two subspecies.

A 100 in x 70 in region of a rocky subtidal reef from the southern coast of Oregon (Cape Arago Lighthouse, Coos County) has been mapped. The frequency of ten habitat types (sand, cobble, boulder, rock flat, sloping wall, vertical wall, overhang, ridge crest, valley, and kelp cover) and the distribution of sessile purple-hinge rock scallops (*Crassadoma gigantea*, formerly *Hinnites gigantea*) was determined by viewing over 900 randomly selected frames from nearly two hours of videotaped transects through the study site. The mean occurrence of rock scallops in all frames viewed was 0.1 1, with very highly significant departures from an even distribution by habitat occurrence. No rock scallops were encountered in sand or kelp-covered areas, low numbers were observed in most habitats, and numerous scallops were found on vertical walls and in cobble areas. Relative to the habitat frequency, rock scallops were found much more frequently on vertical walls and overhangs. Rock scallops measured in the field and the laboratory ranged from < 1 to > 19 cm long, with very few individuals observed < 7 cm. Age was estimated from the number of ridges observed on the hinge ligament, and ranged from 0+ to 9+ years with very few individuals observed < 3 years old. Owing in part to the irregular shell shape, there was great overlap in shell length for 3+ to 9+ year-old rock scallops, making it difficult to assess the age structure of the population solely from size measurements in the field. Nonetheless, recruitment appears to vary greatly from year to year, rendering this population susceptible to overharvesting.

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Effects of impounding coastal salt marsh for mosquito control on microcrustacean populations

Populations of microcrustaceans were studied for 24 months in two New Jersey high salt marsh impoundments, and in three separate 14 month studies of high salt marsh pools in northeastern Massachusetts.

In Massachusetts high marsh pools, dominants were all harpacticoids: *Amphiascus pallidus*, *Cletocamptus deitersi*, *Harpacticus chelifer*, *Mesochra lilljeborgii*, *Metis jousseaumei*, and *Nitokra lacustris*. The cyclopoids *Apocyclops spartinus*, *Halicyclops* sp. and the calanoid *Eurytemora affinis* were also numerically important. While there was extensive overlap, dominants varied to some extent from year to year and among the three studies. The New Jersey saline impoundment fauna showed extreme dominance (low equitability) in the first summer, somewhat less in the second and much less in the third. Total microcrustacean densities also declined each year. Variation in *Apocyclops spartinus* densities was the major factor, as this species comprised in three consecutive summers, 95, 85 and 51% of the total zooplankton at one station. Diversity as species richness was highest in a New Jersey freshwater impoundment which compared well with South Carolina salt marsh values. Impoundment diversity which was very low, and comparable with that found in a New Jersey *Spartina patens* marsh, increased each year becoming progressively more like that found in the Massachusetts fols,

Vegetation changed significantly in the New Jersey impoundments over the three years. *Spartina patens* died-off in the first summer, while *S. alterniflora* gradually declined each year. A visit to the site twenty years later showed all emergent vegetation to be gone. These successional zooplankton and vegetation changes, together with the possible consequences of interrupted marsh-bay exchanges should be considered before undertaking any coastal mosquito control involving permanent flooding.

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Spatial and Temporal Variability of Water Column Parameters (temperature, dissolved oxygen, chlorophyll a, suspended solids) in the Nauset Marsh System, Cape Cod National Seashore

The health of an estuarine system is often evaluated by measuring a suite of biological, chemical and physical parameters such as dissolved oxygen and chlorophyll a, among others. Natural variations in these parameters as a result of dynamic ecosystem processes make it difficult to assess when outside forces, such as anthropogenic nutrient input, are affecting the healthy functioning of an estuary. It is possible that although specific parameters will vary, relationships between two or more parameters may persevere over space and time within a system. This study was initiated in Nauset Marsh (Eastham and Orleans, MA) to identify relationships between parameters that remain similar at different sites within the marsh over a period of time. A suite of twelve parameters was measured at two hydrologically different sites within Nauset Marsh. The measurements were made over the duration of a lunar tidal cycle (=15 days), with one cycle sampled each season of 1994 (March, June, September, November). Principal Components Analysis on four of these parameters (temperature, dissolved oxygen, chlorophyll a, suspended solids) reveals distinct patterns that occur at each site and in the system as a whole. These results demonstrate the importance of tidal stage and season as driving forces for the parameters and can be applied to the design of estuarine water quality monitoring programs.

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VARIABLE FRESHWATER DISCHARGE IN THE KENNEBEC, SHEEPSCOTT, AND THE
DAMARISCOTTA, THE NUTRIENT PERSPECTIVE

Nutrient cycles in the Kennebec, Sheepscott, and Damariscotta River estuaries can provide insights as to how material is processed before entering the coastal zone, and what the dominant mechanisms are behind those processes. The seasonal variability of the nutrients within the estuaries show fairly typical cycles, high concentrations in the winter and depletion during the spring bloom period. The spatial variability within the estuaries during cruise sequences show that there are important differences between the three systems and raises questions as to the role they play in coastal nutrient cycles.

George Smith, Univ. CT Mar. Sci. Dept. Groton, CT 06340
Copepods and eutrophication in Long Island Sound (LIS)

Trophic dynamics in the planktonic community may be said to have two pathways: (1) linear food pyramids, which peak with mesozooplankton and fish, and (2) the microbial loop. If eutrophication is going to alter either of these pathways, it must operate through bottom-up control, but in what ways are they altered? The goal of this research was to determine how the copepods that dominate the mesozooplankton in LIS varied in relation to parameters (nitrogen species and chlorophyll size fractions) associated with a spatial eutrophication gradient. Three stations 45 kilometers apart were visited monthly over a period of 20 months. An East-West trend of increasing eutrophication was observed within the study boundaries, and there was a significant increase in copepod numbers along the gradient. The best explanation for this relationship is that, based on the food limitation model of Huntley and Boyd, the stations differed in the frequency and timing of food limitation.

David Taylor, Scott Nixon, Stephen Granger and Betty Buckley, Graduate School of Oceanography, The University of Rhode Island, Narragansett, RI 02882.
COMPARATIVE IMPACTS OF NUTRIENT ENRICHMENT OF SHALLOW AND DEEP COASTAL MARINE SYSTEMS - DO THEY RESPOND DIFFERENTLY?

Nutrient enrichment has been identified as a threat to coastal systems along the entire east coast of the USA. The systems that are threatened fall into at least two categories - large and frequently deep, phytoplankton-based estuaries and bays, and shallow, usually smaller lagoons and embayments with rooted macrophytes. Much of the research conducted on enrichment of marine systems has focused on the larger, deeper systems. Much less is known of the impacts of enrichment of the shallower systems. In this paper we present the results of gradient enrichment experiment conducted using a series of shallow (1.1 m) mesocosms designed as living models of the lagoons of the northeast. Comparison of the results with those observed in equivalent treatments in an earlier MERL experiment involving deeper (5.0 m), suggests the two types of systems respond to enrichment in different ways. It also indicates that, at least in terms of phytoplankton responses, the shallower systems may be more sensitive to enrichment than the deeper ones.

SEASONAL VARIABILITY IN RESPIRATION RATES AND
BACTERIOPLANKTON PRODUCTION RATES IN MASSACHUSETTS BAY.
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Respiration rates and bacterioplankton production rates were measured during 1993-94 in Massachusetts Bay in conjunction with the Massachusetts Water Resources Authority Baseline Monitoring Program. Massachusetts Bay surface seawater, both whole and 0.8 μm -filtered seawater, was incubated in 12-liter gas-impermeable bags in the dark and subsampled over time. TCO_2 concentrations were measured at a minimum of three time points with the highly precise coulometric technique (Johnson et al. 1993); respiration rates are calculated from linear regression analysis. Bacterioplankton production is calculated both with changes in acridine orange direct counts of bacterial cells and the tritiated thymidine method. The seasonal variability in respiration rates, bacterioplankton production rates and growth efficiencies as well as the differences in respiration rates between whole versus 0.8 μm -filtered seawater will be presented.