

ABSTRACTS

NEERS Spring Meeting and 20th Anniversary

Portland Regency Inn
Portland, Maine

3-5 May 1990

Ackleson, S.G., Bigelow Laboratory for Ocean Science, West Boothbay Harbor, ME, 04575

TOWARDS AN OPTICAL MODEL FOR MASSACHUSETTS BAY

Oceanographic data, including inherent and apparent optical properties, hydrographic conditions, and biological and chemical measurements, were collected along a fixed grid of 18 sampling stations within Massachusetts Bay during four research cruises (24 October 1989, 06 February 1990, 06 March 1990, and 03 April 1990): Two additional research cruises will be conducted within the summer of 1990. This data will be used to construct an optical model for Massachusetts Bay which may be used in future investigations of phytoplankton productivity.

The optical modeling strategy is to define the inherent optical properties of diffuse PAR attenuation and the 1% surface PAR depth in terms of material-specific inherent optical properties (absorption and scattering coefficients) and the concentration of optically important materials (e.g. chlorophyll a, detritus, yellow substance, and suspended sediment). Relationships between the inherent and apparent optical properties and preliminary modeling results will be discussed.

Alber, M. and I. Valiela, Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543.

ASSIMILATION OF ORGANIC AGGREGATES BY BAY SCALLOPS.

We used ^{15}N to trace nitrogen through a detrital pathway: from macrophytes to dissolved organic material (DOM) to organic aggregates to bay scallops (*Argopecten irradians*). We first labelled five macrophyte species (*Fucus*, *Ulva*, *Gracilaria*, *Spartina* and *Zostera*) with ^{15}N and then leached them into filtered seawater to produce ^{15}N -labelled DOM. The DOM was bubbled to form ^{15}N -labelled organic aggregates. Labelled aggregates derived from each species were pulse-fed to bay scallops for 5-24 hrs. ^{15}N label incorporated into the scallops indicated that aggregates were assimilated. Scallops fed aggregates derived from different macrophyte species incorporated the same amount of N, suggesting that scallops did not differentiate between aggregates of different origin.

Babione, M.,* I. Valiela,** C.H. Sham,*** and C. D'Avanzo,*
School of Natural Science,* Hampshire College, Amherst, MA 01002;
Boston University Marine Program,** Marine Biological
Laboratory, Woods Hole, MA 02543; Department of Geography,***
Boston University, Boston, MA 02215 LAND USE CHANGE IN THE WATERSHED OF
WAQUOIT BAY, MASSACHUSETTS.

Groundwater transport of septic nutrients from increased coastal real estate development is causing the eutrophication of Waquoit Bay, an enclosed estuary on the southern shore of Cape Cod, Massachusetts. I examined the history of land use in the bay's seven watersheds by analyzing aerial photographs dating back to 1938. The purpose of my study was two-fold. From the number of houses seen in the photographs, I wished to estimate the loading rates of septic nutrients for each watershed. To obtain this estimate I used published loading rates of N and P per household. I found that septic loading has increased nine-fold since 1938. I also used the geographical information system ARC/INFO to examine general land use change in the watersheds. For example, I found that agricultural use has decreased by 87% in 48 years. Throughout my presentation I will emphasize the limitations of remote sensing when doing this type of ecological research.

Banta, G.T. Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543
SEASONAL PATTERNS OF BENTHIC RESPIRATION AND NITROGEN MINERALIZATION IN BUZZARDS BAY, MASSACHUSETTS: IMPORTANCE OF TEMPERATURE, ORGANIC MATTER AND BENTHIC ANIMALS.

We report a seasonal study of sediment respiration and nitrogen mineralization rates from one station in the coastal embayment Buzzards Bay, MA. The station is located in a water depth of 15 m, sediments are characterized as silt/clay, and the major organic matter inputs are of planktonic origin. Over a period of sixteen months we observed sediment oxygen uptake rates ranging from 62 mmole O m⁻² day⁻² in January to 23.8. mmole O₂ m⁻² day⁻² in August. Temperatures during the same period ranged from 3.8°C to 22.2°C. Seasonal changes in temperature was sufficient to explain the pattern of sediment oxygen uptake during the summer, fall, and winter, but the rapid increase of benthic respiration rates observed in the spring was greater than could be explained by rise in temperature alone.

Nitrogen mineralization rates show similar seasonal patterns to sediment oxygen uptake rates, but they are more variable and less tightly coupled to temperature changes. While much of the nitrogen is released as NH₄, at several times during the year NO₃⁻ made up a substantial portion of the observed flux. Also, the ratio of oxygen flux to nitrogen flux during most of the year was quite close to 13, the value expected from phytoplankton decay. Both of these observations are quite unusual for coastal marine sediments and suggest that even though the sediments of Buzzards Bay are quite oxidized, there is little loss of nitrogen from the system through denitrification.

Sediment chlorophyll a, carbon, and nitrogen content measured throughout the year show that this increase in benthic fluxes is due to the fresh input of organic matter following the spring phytoplankton bloom. These results suggest that the organic matter present in the sediment during most of the year is of poor quality and sediment microbes are usually substrate limited. The seasonal changes of the contributions of benthic macrofauna to the observed fluxes will also be discussed.

Bailey, R. and L. A. Deegan, Dept of Forestry and Wildlife, University of Massachusetts, Amherst, MA 01003.

FEEDING HABITS OF AGE 0 + WINTER FLOUNDER, *Pseudopleuronectes americanus*

Estuaries are critical to many commercial and sport fisheries such as winter flounder, *Pseudopleuronectes americanus*. Winter flounder may be found in certain habitats at different stages of their young life. This study describes feeding periods and feeding preferences with respect to sediment type for age 0+ winter flounder.

Winter flounder were collected from the study site at Waquoit Bay, MA. The food habits of 50 juvenile winter flounder are described. Twenty-five fish were captured from 5 stations in June of 1988, and again in August of the same year. The animals diet is comprised of four main groups: Annelids, Arthropods, Bivalves, Nematodes. Amphipods and polychaetes make up a high percentage. Winter flounder feed greatest during morning hours.

Habitat type as defined by percent sand, silt, and clay was not significantly different between each of the five stations or between the sampling periods. This might suggest that the habitat is supporting the same prey items available to juvenile winter flounder. More data are needed to draw a supportable conclusion. This study sought to investigate what type of habitat best supported y-o-y winter flounder, which is thought to be important information for a fishery faced with habitat loss.

Beatty, K., Fisheries Department, University of Massachusetts, Amherst, MA, 01003

ABIOTIC FLUCTUATIONS AS DETERMINANTS OF SALT MARSH DIVERSITY

Three salt marsh creek-bank stations in Waquoit Bay were studied to determine the role of abiotic variability as determinants of community diversity. Salinity, depth, current velocity, dissolved oxygen level and temperature were sampled to ascertain both spatial variation and temporal fluctuation patterns over a twelve-hour tide cycle. The biotic characteristics were evaluated by taking both water-column and benthic chlorophyll samples, and quadrat counts of sessile bank organisms. The physical and biotic attributes of each station were correlated, suggesting that species diversity decreases in habitats with higher levels of abiotic fluctuation.

Beck, A.D., Narragansett Bay National Estuarine Research Reserve, P.O. Box 151, Providence, RI 02872

NARRAGANSETT BAY RESERVE: An Opportunity For Research.

Established in 1980, the Narragansett Bay National Estuarine Research Reserve (NBNERR) is one of 18 reserves located in coastal areas of the United States. Established as a result of the Coastal Zone Management Act (Calk) of 1972. The National Estuarine Reserve Research System (NERRS) protects nearly 300,000 acres of estuarine waters, marshes, shoreline, and adjacent uplands for research and education. The goal of the NERRS is to establish and manage a system of Reserves representing different coastal regions and estuarine types.

The NBNERR located in the geographic center of Narragansett Bay consists of 1,035 acres of land on Prudence, Patience and Hope Islands and 1,591 acres of water adjoining the islands out to a depth of 18 feet. These islands contain diverse aquatic and terrestrial habitats and are nesting sites for numerous species of birds. The islands are essentially undeveloped, and their distance from urban centers reduces their exposure to chronic pollution associated with urban development. The Reserve provides and unparalleled opportunity for long-term monitoring and scientific research. Projects are designed to develop sufficient understanding to support coastal zone management decisions that protect our estuarine resources.

Berounsky, V.M., Graduate School of Oceanography,
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RATES OF NITRIFICATION AND THEIR IMPORTANCE TO THE NITROGEN CYCLE OF A
COASTAL MARINE ECOSYSTEM.

Rates of water-column nitrification measured seasonally in Narragansett Bay were strongly correlated with temperature. At a nutrient-poor lower bay site, rates ranged from near zero in winter to almost $1 \mu\text{mol N l}^{-1}\text{day}^{-1}$ in summer with an r of 0.96 and an apparent Q_{10} of 6.8. Rates were always higher at a nutrient-rich Providence River estuary site, with a summer maximum over $11 \mu\text{mol N}^{-1} \text{day}^{-1}$, an r^2 of 0.90, and an apparent Q_{10} of 17.6. Laboratory experiments designed to examine temperature alone resulted in a Q_{10} of 7.5. Despite the great temperature sensitivity of nitrification, nitrate concentrations in Narragansett Bay were low during summer because rates of nitrification were balanced by high rates of nitrate uptake by phytoplankton. High nitrate concentrations in fall and winter resulted from a marked decline in phytoplankton uptake and a continuing slow rate of nitrification. The input of nitrate from rivers was small compared to that from nitrification. Both nitrification and phytoplankton uptake contributed to the summer depletion of ammonium. Other nitrogen processes do not appear to respond to temperature as strongly as does nitrification. During long-term warming trends, nitrification rates may increase faster than phytoplankton uptake of ammonium. More nitrate will be available for the phytoplankton. Nitric and nitrous oxides emissions will probably be enhanced.

Bryan, B.B., The BSC Group, Inc. 425 Summer St.,
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THE CENTRAL ARTERY/TUNNEL PROJECT AND BOSTON HARBOR:
REGULATING CHANGE AFTER 350 YEARS

Boston Harbor is one of the most extensively altered estuaries in America. Today, environmental laws designed to regulate filling and pollutant discharges make any further alteration in Boston Harbor very difficult to achieve, and place major constraints of cost, timing, and configuration on a project such as depression of the Central Artery and construction of a third harbor tunnel. The federal Clean Water Act, the Massachusetts Wetland Protection Act, and the Coastal Zone Management program, among others, require investigation of diverse aspects of the estuarine literature. Among the questions to which answers are being sought so that this project can proceed are the constituents of highway runoff and their effect on water quality, whether shad will migrate upstream under a big dark bridge, and how (and if) blasting under the harbor bottom affects the fish swimming above it.

Bum, P., R. Moore, R. Wilkinson, and H. Strauss. Department of Biology, Suffolk University and Division of Nuclear Medicine, Massachusetts General Hospital.

USE OF RADIOPHARMACEUTICALS FOR EVALUATION OF BOSTON HARBOR WINTER FLOUNDER AND LOBSTERS.

Diverse physiological/pathological changes occur in animals from polluted marine habitats, but efforts to evaluate these changes are hampered by invasive and often lethal diagnostic techniques. The pollution of Boston Harbor is well known, and abnormalities of its biota are well documented. In the present study, we investigate the applicability of 5 radiopharmaceuticals for *in vivo* evaluation of normal physiological function and pollution-related alterations in flounder and lobsters.

The pharmaceuticals used were Tc-99m-MDP, Tc-99m-labelled RBC's, Tc-99m-disofenin, Tl-201, and In-111-human IgG, which image bone uptake, blood flow, hepatocyte function, Na-K-ATPase activity, and inflammation respectively. These agents were injected into the blood, and their distribution and uptake determined by scintigraphy and gamma well-counting. The techniques proved to be rewarding (and phylogenetically) robust, replicably imaging function and apparent pathogenesis in both species. Further work will address the applicability of these methods to impact assessment and monitoring.

Deegan, L. A., The Ecosystems Center, MBL, Woods Hole, MA; S. G. Ayvazian, University of Massachusetts, Amherst, MA; J. T. Finn, University of Massachusetts, Amherst, MA.

HABITAT USE BY ESTUARINE FISH ASSEMBLAGES ACROSS TWO BIOGEOGRAPHICAL REGIONS.

A comparison of fish community structure from Wells, Maine and Waquoit Bay, Massachusetts, two physiographically similar estuaries in close geographic vicinity but in different biogeographic zones, will provide a perspective on the variation of critical habitats and fisheries production. Species diversity, abundance and biomass were dramatically lower in Wells. This is attributable to fewer "estuarine-dependent" species, and a lack of "occasional or migrant" fishes. Fish were absent from shallow water habitats in Wells by November, while the same species were present year-round in Waquoit Bay. Mudflats and open bottom areas functioned as nursery grounds in Wells; however exposure during low tide reduced available habitat. Eelgrass and saltmarsh areas were more important in Waquoit Bay.

Drapeau, D.T., B.L. Welsh, F.C. Eller, and J.M. Johnson, Dept. of Marine Sciences, The University of Connecticut, Groton, CT 06340 THE ROLE OF WATER COLUMN MICROHETEROTROPHS IN SUMMERTIME OXYGEN DEPLETION IN LONG ISLAND SOUND.

Hypoxic conditions in the bottom waters of western Long Island Sound occur annually in the summer. Oxygen profiles and light/dark bottle incubations conducted over the past several years have shown a narrow zone of net oxygen production at the surface followed by a zone of high respiration between the surface and the pycnocline. Metabolic activity below the pycnocline was characteristically low. Preliminary results of a study of bacterial abundances begun in 1989, suggest that large populations of free living bacteria and the microzooplankton which graze on them are responsible for the majority of water column oxygen demand. These water column microheterotrophs are closely coupled in time and space to phytoplankton production, and provide a biological mechanism for preventing the reoxygenation of waters below the relatively weak pycnocline present in Long Island Sound.

Fraher, James and Barry Huebert, Center for Atmospheric Studies
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PROBING PRUDENCE PRECIPITATION POTENTIAL

Local meteorology and rainfall are important consideration in studying' an estuary. Precipitation is particular) interesting because it is also source of fixed nitrogen.

Our group has been measuring atmospheric wet deposition an local meteorology for one and a half years at the Narraganset Bay National Estuarine Research Reserve. Rainwater samples are collected weekly by local volunteers. Analysis includes pH nitrate and ammonia. The data is used to estimate wet deposition of nitrogen to the Bay. Preliminary estimates indicate 9-12% o the Bay's annual nitrogen budget is from wet deposition. Our longterm goals are to provide future investigators wit biologically useful data such as solar radiation and temperature and precipitation.

Future work will include the addition of an annular denude and micrometeorological measurements to estimate dry deposition using the inferential method. Our research site is also being expanded to include an educational display.

Garrett, M.J. and W. Waldron, (1990) Sanford Ecological Services, Inc., 258 Main Street, Bourne, MA 02532
DEVELOPMENT OF A COMPREHENSIVE MANAGEMENT PLAN - BUTTONWOOD BROOK
IN DARTMOUTH, MASSACHUSETTS

Sanford Ecological Services, Inc. (SES), under the authority of the Town of Dartmouth, Massachusetts and the EPA's Buzzards Bay Project, has developed and is conducting a watershed analysis to provide guidance and strategies to potentially mitigate impacts to a valuable shellfish resource in Apponagansett Bay. At present, the shellfish resource is closed under Massachusetts General Law due bacteriological pollution. The goal of this year long evaluation is to provide the town a cost effective technical database and recommendations to develop a comprehensive plan which defines feasible management strategies. The study design reviews water quality data collected from strategic sampling points. These sampling points are selected based on current watershed land uses, zoning, and locations of Nonpoint pollution sources.

Charles, Elizabeth, Waquoit Bay National Estuarine Research Reserve,
P.O. Box 92W, Waquoit, MA 02536
WAQUOIT BAY NATIONAL ESTUARINE RESEARCH RESERVE (WBNERR)

WBNERR, located in the towns of Falmouth and Mashpee on the southern shore of Cape Cod, represents the Southern New England portion of the Virginian biogeographic region. It includes 2,500 acres of open water, marshes, and coastal upland. In 1990 NOAA has funded five research proposals at the Reserve including studies of fish, shellfish, eelgrass, macroalgae and Bay circulation and flushing rates. A Land Margin Ecosystem Research grant, jointly funded by NOAA, EPA and NSF, has been awarded to a group of researchers from five institutions to study the "Coupling of Watershed and Coastal Waters in Waquoit Bay". Other work involves Piping Plover, Osprey, and salt marsh response to sea level rise. WBNERR is pursuing grants to translate the results of the research for the public, in particular, policy makers.

Hale, S., E. Bishop, and S. Smith, Grad. School of Oceanography and Dept. of Natural Resources Science, Univ. of RI, and Narragansett Bay Project, Narragansett, RI 02882.

A CENTRALIZED DATA MANAGEMENT SYSTEM FOR NARRAGANSETT BAY

The amount of information required for addressing the wide range of estuarine problems requires an organized approach to management of data from both the estuary and its watershed. Data scattered over several institutions, media, computers, and software make analysis and management of the ecosystem difficult. The Narragansett Bay Project is developing a centralized data system for the Bay using commercial DBMS (data base management system) and GIS (Geographic Information System) software. Researchers and managers can search an index to studies from various perspectives such as variables measured, location, or time. Data can be analyzed within the data system or downloaded to microcomputers for further analysis. The GIS is used for mapping and analyzing spatial data and for integrating watershed data with estuarine data.

D.Hersh. Boston Univ. Marine Program. Marine Biological Laboratory. Woods Hole, MA 02543.
INTERACTION OF GRAZING AND NITROGEN LOADING ON PRODUCTION OF PHENOLICS IN *SPARTINA ALTERNIFLORA*

Phenolic compounds are secondary metabolites found in marine vascular plants as well as many species of macroalgae. These compounds have demonstrated anti-herbivore and anti-microbial properties in live tissue and in some cases influence decomposition rates of detritus. In *S. alterniflora*, the concentration of phenolics increases in response to grazing and decreases with nitrogen fertilization. The interactive effects of grazing and nutrient loading on the concentration of phenolics in *S. alterniflora* was tested in the field in a factorial designed experiment. Soluble and bound phenolics, lignin and carbohydrates were measured. These results indicate that nutrient loading reduces the ability of the plant to respond to grazing.

Howell, W.H., W.H. Watson and A. Vetrovs, Dept. of Zoology,
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DISTRIBUTION OF LOBSTERS IN THE GREAT BAY ESTUARY, NEW HAMPSHIRE.

The objective of the research was to examine the spatial and temporal distribution of lobsters in the Great Bay Estuary. From 1987-89 we gathered data on catch-per-unit effort (CPUE), size, and sex of lobsters from 5 separate locations extending from the New Hampshire coast to the middle of Great Bay, some 14 miles up the estuary. We also tagged more than 4,000 animals, some with ultrasonic transmitters, to examine movement patterns. Mean numbers caught per trap haul (all size classes) decreased from 3.9 at the coastal location to 0.4 at the station locate furthest up the estuary. Mean carapace lengths differed between locations, with the largest lobsters ($\bar{x}=82$ mm CL) located furthest up the estuary. While mean size was similar in 3 of the 4 remaining locations, one location in the middle of the estuary had lobsters that were significantly smaller ($\bar{x}=71$ mm CL) than elsewhere. Sex ratios also differed between locations. At the coastal station the M:F ratio was about 1:1, but the population became increasingly dominated by males further up the estuary. At the station furthest from the coast the M:F ratio was >8:1. Results from about 500 tag returns, and the telemetry studies, indicated that lobster movements in the estuary were limited, typically to less than 3 miles. There was a tendency, however, for lobsters to move down the estuary in late fall and up the estuary in early spring.

Incze, L.S.,¹ R.A. Wahle² and T. Ainaire¹. ¹ Bigelow Laboratory for Ocean Sciences, West Boothbay Harbor, ME 04575 and ² Ira C. Darling Center, University of Maine, Walpole, ME 04573.
LARVAL LOBSTERS AND THE RECRUITMENT PROBLEM: STUDIES IN AND AROUND JOHNS BAY, MAINE.

Planktonic stages of lobsters (Homarus americanus) were sampled with a neuston net to examine temporal and spatial patterns of development and to establish estimates of abundance of the final planktonic stage (=postlarva, PL). The peak abundance of PLs in Johns Bay during 1989 was 120 PLs (1000 m²)⁻¹ (0.5 m)⁻¹, and the seasonal peak averaged for all bay stations was 9.8 (1000 m²)⁻¹ (0.5 m)⁻¹ in early August. Early benthic phase (EBP) lobsters were sampled at a variety of known recruitment sites in June and late September (before and after settlement of the 1989 year-class). New recruits in September averaged 1.6 +/- 0.6 m² (Mean +/- 1 SD). The quantitative relationship between PLs and 0-age EBPs is being examined with respect to advection, planktonic development, searching behavior and the planktonic-benthic transition in this organism.

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ORIGIN AND EVOLUTION OF THE SEAFLOOR OF THE ESTUARIES AND INNER
CONTINENTAL SHELF OF THE WESTERN GULF OF MAINE

The Maine Geological Survey and the University of Maine have gathered thousands of kilometers of side scan sonar and seismic reflection observations, collected and analyzed almost 2000 bottom samples and 12 vibracores, and made more than 50 submersible dives from 0-100 m depth in the western Gulf of Maine. Modern sediment was first introduced here around 14,000 BP as melting ice, in contact with the sea, crossed the shoreline. Gravelly glacial till was irregularly deposited across the region and buried by muddy, well-layered glaciomarine sediment. In depressions, like former river valleys, sediment accumulation exceeded 50 m. After reaching a highstand more than 100 km inland from the present coast around 13000 BP, sea level fell to a lowstand at 60 m (present) depth around 10000 BP. As sea level fell older sediment was reworked by nearshore processes from high to lower elevations, and locally, river sediment accumulated on these reworked deposits. Sea level has risen since then, and again coastal processes have reworked older sediment. Presently, new terrestrial sediment is primarily introduced from bluff erosion, and mechanisms like submarine landslides, gas escape cratering, and coastal downwelling during storms appear to move sediment out of the coastal zone and into deeper water. Thus, much of the inner shelf seafloor is relict.

Kindblom, L. and H. Hidu, Darling Marine Center, University of
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The role of eelgrass in the settlement of *Mytilus edulis*.

Juvenile blue mussels are often found on the blades of eelgrass, *Zostera marina*, in the Jordan River estuary. However, the importance of eelgrass to the settlement and subsequent recruitment of mussels to the estuary is unknown. The distribution and abundance of larval and juvenile mussels in the water column are compared with hydrographic data to determine the role of eelgrass in the settlement of larval mussels, and the environmental conditions under which settlement occurs. Plankton samples and vertical velocity profiles were collected over seven, 12-hour tide cycles during the summer of 1989. Plankton samples were pumped inshore, within, and offshore of an eelgrass bed along a transect parallel to the flow of tidal currents. Vertical velocity profiles were made at these sites to determine the effects of an eelgrass bed on tidal flow. This research should give us a better understanding of the passive and active mechanisms involved in the settlement of larval mussels.

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WELLS NATIONAL ESTUARINE RESEARCH RESERVE

The Wells National Estuarine Research Reserve encompasses approximately 1,600 acres of undeveloped marsh system and transitional upland fields and forests, occurring along two contrasting watersheds - the Little River Estuary and the Webhannet River Estuary. The area's unique habitats support a diverse abundance of flora and fauna. Sitting atop a rise of glacial till, the Reserve's visitor center provides a spectacular view of the Webhannet River Estuary.

Research conducted at the Reserve is directed toward enhanced resource management through improved understanding of ecosystem productivity and life requirements of its flora and fauna; and toward addressing threats to the estuarine environment that are of national significance.

Educational opportunities at the Wells Reserve are designed to help people discover and understand the intricacies of life in an estuary and to appreciate the role this area plays in their everyday lives.

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WINTER OCCURRENCE OF LATE-SPAWNED ATLANTIC HERRING, CLUPEA HARENGUS, LARVAE IN THE SHEEPSCOT RIVER ESTUARY, MAINE.

Collection of Atlantic herring larvae usually peaked in October-early November in buoyed and anchored nets set in the Sheepscot River estuary of Maine since 1965. These larvae were spawned primarily in Canadian waters off Grand Manan Island and the eastern Maine coast during August-September and transported to the Sheepscot River by coastal currents. However, the appearance of large numbers (> 1.0 larvae/ 100 cubic meters) of small (< 15 mm SL) larvae in December and January of some years from 1974 through 1989 suggested an additional area of origin. Examination of daily ring counts of otoliths since 1983 indicated that these small herring larvae were spawned from mid October-late November in the coastal waters of western Maine and Massachusetts.

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WAVE-CURRENT INTERACTION AT WELLS INLET, MAINE.

Wells Inlet is a double-jettied tidal inlet along the • southern coast of Maine. Since its initial structuring and dredging for harborage in 1962, Wells Inlet has been plagued by severe shoaling. The jetties are constructed normal to the dominant wave approach and thus, also fail to provide shelter from waves and swells. Despite several modifications and dredging attempts, shoaling and large waves have persisted in the inlet. The channel thalweg is dominated by ebb currents while the shallower sections of the channel, adjacent to the jetties, are flood dominated. This segregation of flow is corroborated by bedform patterns. Waves breaking inside the inlet create pulses of landward flow that enhance flood currents and retard ebb currents. This wave condition is best defined by Solitary Wave Theory, where water parcels move only in the direction of wave propagation, with no associated return flow with the passage of the trough. Sand is transported into the inlet by shoaling and breaking waves, particularly along the shallower portions of the channel, adjacent to the jetties.

Macfarlane, S., Town of Orleans Shellfish Department, Orleans, Ma.02653 THE EVOLUTION OF A MUNICIPAL QUAHAUG MANAGEMENT PROGRAM: 1975-1990

Use of hatchery-raised seed quahaugs (*Mercenaria mercenaria*) for a municipal seeding program began in 1975 for the Town of Orleans, Cape Cod, Ma. as an experimental endeavor. The town developed bottom culture methods and off-bottom culture using rafts as floating sand boxes. Both increased costs of seed and the fortuitous relocation of a small building to a waterfront site, allowed the town to design, equip and operate a small hatchery using low cost technology and natural spawning conditions. However, overwintering and townwide financial problems terminated the hatchery concept and lead to the use of upwellers with the seawater system already installed for the building. During the years 1986-1989, the town raised 1,000,000 seed quahaugs annually at over 90% survival, that were transplanted throughout the town each November. The State's fiscal morass has forced the closing of the shellfish lab. and the return to experiments of nursery methods using bottom and off-bottom culture at reduced numbers of seed and the exclusion of additional labor. Problems, successes, environmental changes, water quality degradation, and the educational benefit to the community, were all part of the program culminating in a change of job description for the author.

Michael LaMontagne, Ivan Valiela, and Merryl Alber, Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA 02543 and George Heufelder Barnstable County Health and Environmental Dept. Barnstable, MA.

Fecal Coliform Loadings and Pools in Buttermilk Bay, Mass., and Management Implications

We constructed a rough fecal coliform budget for Buttermilk Bay and compared the calculated estimates of density of fecal coliforms in the water column with measured concentrations. Our calculated losses were an order of magnitude higher than our sources, and our calculated standing stock was an order of magnitude lower than measured standing stocks. We hypothesize that growth and resuspension of coliforms in sediments may be an important source of fecal coliforms to the water column. Reducing inputs from run-off, waterfowl, etc., may not be effective in reducing water column coliform levels.

Milliken, A.S., Taylor, D.I., Granger, S.L. and Nixon,, S.W. Graduate School of Oceanography, University of Rhode Island, Narragansett, RI 02882

DIEL METABOLISM IN COASTAL LAGOONS IN RESPONSE TO NUTRIENT ENRICHMENT - A MESOCOSM EXPERIMENT

In order to study the effect of nutrient enrichment on the ecological processes in shallow coastal lagoons, a mesocosm facility was constructed at the Graduate School of Oceanography at the University of Rhode Island. The facility consists of ten mesocosm tanks, each with an area of 5 m², a water depth of 1.2 meters and 40 cm of vegetated and unvegetated sediment. The mesocosms are mixed by paddle wheels and flushed with seawater at the rate of 5% per day. Nitrate is added daily to seven of the mesocosms at rates equal to 1X, 3X and 6X the present input to Rhode Island coastal lagoons. Diel oxygen measurements were made of the total system and water column (using integrated water column enclosures) weekly during the summer of 1989 while benthic fluxes were measured monthly using benthic chambers. Preliminary analysis of the data indicates that there was no significant correlation between nutrient loading and levels of community metabolism. Measurements of the individual components of community metabolism indicate the relative importance of macroalgae primary production. Measurements of the individual components of community metabolism indicate the relative importance of macroalgae.

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THE ROLE OF HIGH SALT MARSH IN THE FISH PRODUCTION OF MAINE ESTUARIES, H; GROWTH.

The high marsh systems of the Wells National Estuary Research Reserve are known to be accessed by fish during the flood stage of spring tides. The risk of this temporary habitat could be for spawning, feeding, or movement to the often supertidal salt pannes on the high marsh. The usefulness for foraging on the marsh surface vs. in the salt panne is the basis for this paper.

Orson, R.A., R.L. Simpson, School of Science and Mathematics, William Paterson College, Wayne, New Jersey 07470 and R.E. Good, Center for Coastal and Environmental Studies and Biology Dept., Rutgers University, Camden, New Jersey 08102.

RATES OF SEDIMENT ACCUMULATION IN A TIDAL FRESHWATER MARSH.

Rates of sediment accumulation for an upper Delaware River estuarine tidal freshwater marsh were determined using ²¹⁰Pb and ¹³⁷Cs geochronologies, palynological analysis and sediment flux techniques. Between 1940 and 1988 sediment accumulation rates averaged 1.20 cm yr⁻¹. During a period of increased storm activity (1954 - 1965) rates averaged 1.67 cm yr⁻¹. Since 1966 storm activity has decreased and sediment accumulation rates have averaged 0.97 cm yr⁻¹. The current rate of accumulation is four times the rate of sea level rise for this region of the estuary. It is hypothesized that sediment accumulation rates will continue to exceed rates of sea level rise until the marsh surface approximates mean high water. It is clear from this investigation that tidal freshwater marshes are capable of preserving evidence of processes and events that have shaped the estuary through time.

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EFFECTS OF NUTRIENT LOADING ON ALGAL GROWTH AND NUTRIENT UPTAKE

This study investigates the physiological response of the nuisance macroalgae, Cladophora vagabunda and Gracilaria tikvahiae, to disparate nutrient loading rates into Waquoit Bay, a National Estuarine Research Reserve. We compared algae collected from two sites: one, bordered by a pristine salt marsh and the other, a site surrounded by a highly developed area. Houses bordering the latter site use septic tanks for wastewater disposal. Growth of both Cladophora and Gracilaria is light-limited at 2.5 m; nutrient enrichment had little effect on growth rates at this depth (experiments run May-Nov). Growth rates were strongly enhanced with fertilization (slow-release NH_4NO_3 at 0.5 m depth, emphasizing the dramatic impact of nutrient input into shallow portions of the Bay. Summertime ammonium uptake rates of N-enriched populations of Cladophora and Gracilaria were much higher than rates measured for algae from the salt marsh site. During autumn, algae from both sites showed similar uptake rates. Further, V_{max} and K values were significantly lower (ca. 25% of summer values) during autumn compared with summer for both species. Seasonal patterns of algal biomass and physiology are strongly coupled to the benthos of Waquoit Bay, resulting in a dramatic "control" of this environment by the macroalgal producers.

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GREAT BAY NATIONAL ESTUARINE RESEARCH RESERVE

Designated on 3 October 1989, the Great Bay National Estuarine Research Reserve is the newest in the National Estuarine Reserve Research System and the fourth New England reserve. As the only Reserve with a research laboratory (the Jackson Estuarine Lab) within its boundaries, the Great Bay NERR can draw upon the substantial history of research activities within the Estuary. Likewise, the Reserve's education programs will cooperate with existing University and Extension public education programs.

The Great Bay NERR includes 4,471 acres of tidal waters, 800 acres of upland and approximately 48 miles of shoreline. Great Bay contains diverse habitats that include rocky macroalgal-dominated shores, salt marsh, eelgrass and substantial intertidal mudflats. Great Bay is a tidally-dominated, turbid estuary. Great Bay is quite shallow and undergoes large seasonal temperature variation (-2 to 28°C).

While other parts of the Great Bay Estuary are industrially developed, the Great Bay NERR shore is still rural with only limited residential development. Several POTW empty into the Estuary and substantial areas of shellfish habitat are dosed to harvesting due to poor microbial water quality. Historically, numerous tanneries and metal plating industries discharged wastes into the entire Great Bay Estuary. While current release of toxic substances into the Bay is restricted, there are areas with high sediment concentrations of chromium, lead and copper.

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RELATION OF COASTAL WAVE PATTERNS TO WAVE SURGE IN THE ORIENT POINT BOAT BASIN

A wave surge problem exists within the U. S. Department of Agriculture's boat basin at Orient Point, Long Island, New York. Analyses of winds, predicted wave characteristics, wave refraction, and wave energy were conducted to determine the cause of the wave surge and to investigate possible by solutions. Refraction analysis shows that most waves are minimally affected by the bathymetry outside of the basin. Rather, the surge is created by wave interaction within the basin.

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FACTORS CONTROLLING DECOMPOSITION IN COASTAL MARINE SEDIMENTS

We investigated the interaction between the presence or absence of oxygen and the quality of detrital material in determining rates of decomposition. It is generally hypothesized that aerobic decomposition is inherently faster than anaerobic decomposition. Using a flow-through system, we tested this hypothesis for a wide range of detrital quality: Skeletonema costatum (expected to be most labile), Synechococcus sp. (expected to be of intermediate quality), and Spartina alterniflora (expected to be most refractory). For Skeletonema and Synechococcus, the hypothesis was supported by the finding of faster decomposition rates in the oxic treatment. For Spartina, however, our results indicated that anaerobic decomposition was faster.

A possible explanation for the lower aerobic decomposition rates for Spartina might be that the two treatments received inflow water with different nutrient concentrations. The oxic treatment received filtered seawater that was very low in nutrients while the anoxic treatment received porewater from a B1177ards Bay sediment core that was higher in nutrients. Of the three detrital types we tested, Spartina is poorest in nutrient quality, and we hypothesized that its decomposition may be more dependent on external sources of nutrients. We tested this idea by spiking the oxic inflow water with nutrient concentrations similar to those in the porewater. Preliminary results will be discussed.

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EFFECTS OF TEMPERATURE, PHOTOPERIOD, AND NITRATE AVAILABILITY ON NITRATE REDUCTASE ACTIVITY IN EELGRASS (*ZOSTERA MARINA*).

The activity of nitrate reductase (NR) in eelgrass (*Zostera marina*) leaf tissue was measured under varying conditions of temperature, photoperiod, and NO₃ enrichment. Plants were collected from Great Harbor, Woods Hole, MA between September 1989 and March 1990. In the first experiment, nitrate enrichment caused a 3-fold increase in NR activity (164 vs 514 nmoles NO₂/gfw/h) under winter conditions (8 h light, 8° C), and a 1.5-fold increase (43 vs 72 nmoles NO₂/gfw/h) under summer conditions (16 h light, 8° C), indicating a non-additive interaction of enrichment and season. Further replication showed similar results, but with greater NR activity in unenriched than enriched plants under summer conditions (206 ± 198 vs 106 ± 23 nmoles NO₂/gfw/h) owing to high plant-to-plant variability similar to that observed by other researchers. To determine the relative importance of photoperiod and temperature, plants were grown in short and long photoperiods, both at 8° C. Enriched plants in 16 h light had NR activity 1.6 times that of unenriched plants (88 ± 50 vs 54 ± 55 nmoles NO₂/gfw/h). In 8 h light, enriched plants had an activity 1.2 times higher than unenriched plants (38 ± 22 vs 32 ± 37 nmoles NO₂/gfw/h). These results suggest that temperature is perhaps a more important determining factor of NR activity than is photoperiod, but the interaction of photoperiod and temperature results in greater sensitivity to nitrate enrichment during "winter" than "summer" conditions. This observed behavior has important implications for seasonal growth of eelgrass and for coastal nutrient loading.