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Abstracts

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and

Waquoit Bay National

Estuarine Research Reserve

OF INCREASED TIDAL FLUSHING IN AN IMPOUNDED ESTUARY

Holly Pond, an urban impounded salt pond off Long Island Sound, serves as a scenic and recreational resource for the cities of Stamford and Darien, CT. Management plans included repair of the dam to improve tidal flushing and alleviate hypoxia in summer. This study was to develop baseline data before the tidal regime was altered. However, the dam was breached by natural causes during the study, converting a large area of the pond from subtidal to intertidal habitat. Macroalgae responded by a change in species distributions. Physical and chemical stratification in the pond was more influenced by runoff and other seasonal effects than by increased flushing. Variability in salinity, oxygen and pH increased with distance from Long Island Sound. Oxygen distributions were regulated by macroalgal and microalgal photosynthesis rather than by tidal exchange.

Banta, C.T., Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA, 02543.
EXPERIMENTAL STUDIES ON THE EFFECTS OF BENTHIC MACROFAUNA ON AEROBIC AND ANAEROBIC MICROBIAL PROCESSES IN MARINE SEDIMENTS.

The effects of benthic animals on aerobic and anaerobic microbial processes were studied during the fall of 1987 by manipulating macrofaunal communities in microcosms of coastal marine sediments. Macrofauna were removed by gently sieving the top 2 cm of six microcosms while leaving the remaining sediment profile undisturbed. *Mediomastus ambiseta* (a small, numerically important polychaete) was added back in two densities (6000 m^{-2} and 45000 m^{-2}) to four of these microcosms. In two microcosms the benthic communities were left intact. Benthic fluxes of O_2 , DIC, NH_4^+ and NO_3^- were monitored during the experiment. Profiles of sulfate reduction rates, pore water constituents (SO_4^{2-} , sulfides, alkalinity, NH_4^+ , and NO_3^-), and bulk sediment parameters (porosity, and Cr-reducible S) were determined at the conclusion of the experiment. Few differences in O_2 uptake and fluxes of DIC and nitrogen were observed among the different treatments. Differences in pore water and sediment profiles, as well as the partitioning of aerobic and anaerobic processes, will be discussed.

Barr, Bradley W., Massachusetts Coastal Zone Management, Boston, Massachusetts. ENVIRONMENTAL IMPACTS OF SMALL DOCKS AND PIERS: STATE OF THE ART AND RESEARCH NEEDS.

Small coastal structures, such as private, non-commercial docks, have come under close scrutiny recently by environmental regulatory agencies as a result of the proliferation of such structures along previously undeveloped or sparsely developed shorelines. The trend is toward larger, more heavily-engineered structures which may extend hundreds of feet into embayments or other coastal water bodies. However, the current state of our understanding with regard to the potential adverse direct and cumulative effects of the construction and use of these structures is poorly developed, at best. A status report of information currently available will be presented, ongoing efforts by agencies of the Commonwealth of Massachusetts to fill these gaps will be discussed, and recommendations for necessary research and potential funding sources will be offered.

Boehm, P.D., S. T. Freitas, E.A. Creelius, and R. I. Hillman, Battelle Ocean Sciences, Duxbury, MA

TRACE ORGANIC AND METAL DISTRIBUTIONS IN BIVALVES AND SEDIMENTS FROM THE ATLANTIC AND PACIFIC U.S. COASTS.

The NOAA Mussel Watch Program, one component of the National Status and Trends (NS&T) Program, is a marine monitoring program that relies on repeated, precision sampling and chemical analysis of sentinel organisms and depositional sediments. The goal of Mussel Watch is to quantify the current status of environmental quality of the nation's coastal and estuarine regions and measure long-term spatial and temporal changes in concentrations of environmental contaminants. This fully interpreted national database will provide a foundation for environmental management decisions and for testing scientific hypotheses on future marine pollution impacts.

Two years of data have been generated at more than 100 Atlantic and Pacific coastal sites. Patterns and relationships among chemical parameters will be discussed.

Buchsbaum, R.¹, F.T. Short², and D.P. Cheney³. ¹Mass. Audubon Soc., Gloucester, MA;

²Jackson Estuarine Lab. UNH, Durham, NH; and ³Northeastern Univ. Boston, MA.

PHENOLIC-NITROGEN INTERACTIONS IN EELGRASS, A LINK BETWEEN GROWTH RATE AND WASTING DISEASE.

Wasting disease, a parasite-born infection, is responsible for recent declines in some eelgrass (*Zostera marina*) populations along the northeast coast of the United States. The environmental determinants of outbreaks are unknown. We investigated the role that nitrogen and secondary metabolites may play in altering susceptibility of eelgrass to the organism responsible for the current eelgrass disease. Eelgrass seedlings were transplanted into two mesocosm tanks that differed in the amount of nitrogen available to the plants. Plants from the high nitrogen tank had higher nitrogen contents and grew faster than those from the low N tank. The high N plants eventually suffered complete mortality due to wasting disease. Plants from the low N tank initially showed the characteristic black lesions of *Labyrinthula* infection, but eventually recovered. The low N plants had significantly higher levels of soluble phenolics and these may inhibit the parasite.

Burn, P. R., Dept. of Biology, Suffolk University, Boston, MA

THE GENUS *DINOPHILUS* (ANNELIDA: POLYCHAETA) IN NEW ENGLAND

Two species of the genus *Dinophilus* are present in New England. The worms are small (~1mm), with little apparent metamerism. Formerly considered to be primitively simple (i.e. archiannelids), the secondarily reduced nature of the genus is revealed by the clear metamerism of the nervous system. The species have certain interesting features. *D. gyrociates* is strongly sexually dimorphic, with no free-living males. The more common *D. gardineri* is monomorphic, and has been collected in salt marshes from Eastport, Maine to Pt. Judith, RI. The worm can occur at high population densities, which vary seasonally as a function of the encystment of adult animals. Encystment is most apparent during the summer months, during which times no free-living worms are found at the southernmost limits of the species range. Factors affecting summer encystment of *D. gardineri* will be examined.

Colarusso, P.D., Environmental Sciences Program, Univ. of MA/Boston, Boston, MA 02125

BENZO(A)PYRENE METABOLISM BY THE GREEN CRAB, *Carcinus maenas*

In vivo metabolism of the carcinogenic polyaromatic hydrocarbon benzo(a)pyrene was examined in green crab fed a single dose of radiolabelled benzo(a)pyrene. The fate of the parent compound and metabolites in the crabs was examined at several time points ranging from 1 to 12 days. After 12 days, 15% of the dose was still retained by the crabs with the hepatopancreas containing the greatest amount of activity at all time points. Analysis of hepatopancreas for metabolic products indicated that benzo(a)pyrene was metabolized quickly and metabolic products were still present after 12 days.

Costa, J.E., Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA. DISTRIBUTION, PRODUCTION, AND HISTORICAL CHANGES OF EELGRASS (*Zostera marina* L.) IN BUZZARDS BAY.

The past and present-day distribution of eelgrass (*Zostera marina* L.) was documented using aerial photographs, field surveys, nautical charts, and sediment cores. Today, eelgrass beds cover 41 km² of substrate in Buzzards Bay. Eelgrass growth correlated with local temperature and insulation, and production is =350 g C m⁻² yr⁻¹. Eelgrass accounts for 12% of all primary production in Buzzards Bay, but in shallow bays, equals 40% of production. Prior to the wasting disease of 1931-32, eelgrass populations equaled or exceeded present-day abundance, but 6 to 10 years later, covered less than 10% of today's habitat area. Recolonization was gradual, and onset of colonization depended on distance from refuge populations. By the 1960's and 70's, most populations reached peak cover. Eelgrass is still expanding in some areas today, but new long-lasting declines have occurred because of human disturbance. The process of recolonization after the disease was similar in many areas: new beds appeared on bare substrate, beds expanded, additional beds appeared, and some beds were removed by disturbance. A computer simulation modeled these events, and showed that rapid recolonization of eelgrass populations is highly dependant on new bed recruitment.

Dean, D., Dept. of Zoology, Univ. of Maine, Darling Center, Walpole, Maine. MYXICOLA INFUNDIBULUM, ONE OF THE MOST PRIZED RESOURCES IN OUR NORTHERN ESTUARIES.

This filter-feeding polychaetous annelid has the largest true giant axon of any species in the Animal Kingdom. Because of this, the species is in demand by researchers in various areas of neurobiological research, e.g., neurophysiology, neuropharmacology, biophysics, etc. Due to the difficulty in obtaining undamaged adults for research, a price of \$15 each plus S & H is normal. A culture program has been in progress for over four years. Development through the F₂ generation has been completed. Aspects of habitat variability, regeneration and behavior are presented.

Edwards, D. C., and M. Fregeau. Dept. of Zool., Univ. of Massachusetts, Amherst, MA.
MOLLUSCAN ASSEMBLAGES OF INLAND, TIDAL BLUE HOLES, SAN SAI.VADOR
ISLAND, BAHAMAS.

Quantitative random sampling was used to determine the composition, structure, and populational features of the molluscan assemblages in two hydrographically similar, brackish (29-30 ‰) blue holes. Despite their similar physical characteristics, proximity (600 m), identical species richness (S=5), and sharing of 4 species in common, the "replicate" sites differed greatly in the structures of their molluscan assemblages. The massive dominance of Batillaria minima at Watling's Blue Hole was lacking at Blue Hole 2, where B. minima was absent and Cerithidea costata, a rarity at WBH, was dominant. Similarly for bivalves, the dominance relations between Anomalocardia auberiana and Polymesoda maritima were reversed between sites. Species evenness and H' diversity were greater at BH2, but the high concentration of dominance at both sites approached the log series pattern. Most molluscs were taken in shallow or intertidal depths, and most species were represented by one or two size classes. Competitive and historic considerations may account for currently similar, nearby blue hole "islands" of marine habitat having quite different molluscan assemblages.

Foreman, Kenneth H. Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA. The relative importance of predation and resources in regulating a salt marsh meiobenthic community.

The two factors generally regarded as important in regulating natural communities are predation and resources. Yet there are few experimental studies in marine systems in which both these factors are manipulated simultaneously. I increased resources by fertilizing small experimental plots with urea or sewage sludge based fertilizer. Predation on the henthos by fish (*Fundulus heteroclitus*), shrimp (*Palaemonetes* spp.) and crabs (*Carcinus maenas* and *Uca pugnax*) was simultaneously reduced in sections of these experimental plots covered by exclusion cages. Meiofauna in the various treatments were systematically censused. By far the most abundant meiofaunal taxa is nematodes. Their densities increased dramatically inside fertilized plots (averaging 3X higher in enriched than control sediments), and reached very high levels (ca. 10,000 per 10 cm²) inside cages placed in the fertilized plots. Estimates of the effect of the treatments on the carrying capacity and growth rate of the assemblage of nematodes found in control and fertilized plots were made by fitting a logistic growth curve to the data.

Giblin, A.E., C. Banta, J. Tucker, J.E. Hobbie, Ecosystems Center. MBL, Woods Hole, MA, 02543. A COMPARISON OF LABORATORY AND IN-SITU MEASUREMENTS OF SULFATE REDUCTION AND ACETATE TURNOVER IN SALTMARSH SEDIMENTS.

The roots of salt marsh plants contain labile organic compounds which may potentially be released when roots are cut by sediment coring. We determined that acetate concentrations in porewaters of cores taken from the marsh were higher than porewater gently removed from undisturbed peat using a syringe. To determine if this release of acetate affected the measurement of sulfate reduction and acetate turnover rates, we directly injected the tracers into undisturbed marsh sediments and incubated in-situ. We compared these rates to ones measured using the standard method of removing cores from the field and incubating them in the laboratory. Sulfate reduction rates in undisturbed sediments were not significantly different from those incubated in the lab. Acetate turnover rates were much lower than expected from sulfate reduction rates. This indicates that sulfate reduction in salt marsh sediments is largely fueled by organic matter sources other than acetate for at least part of the year.

Gregory, C.J., Dept. of Botany and Plant Pathology, Univ. of Maine, Orono, Maine.

CONTRIBUTION OF THE CILIATED PROTOZOA TO THE MICROPLANKTON BIOMASS IN THE GULF OF MAINE, DURING 1987.

From February to August, 1987, preserved water column samples from six oceanographic cruises were examined for microplankton (2-200 μm) taxonomic composition, numerical abundance, and biomass as organic carbon. Samples were taken at various depth intervals. Inverted microscopic techniques were utilized to identify and count various species, plus determine cell dimensions. Total microplankton biomass over all euphotic zone samples varied by two orders of magnitude (1.5 to 150 $\mu\text{g C/L}$). Biomass values for the ciliated protozoa (tintinnids and naked cells) reached 31.3 $\mu\text{g C/L}$ during July (21, total biomass). Naked ciliates (e.g. Strobilidium spp.) dominated the total ciliated protozoan abundance and biomass over loricate ciliates. The importance of these findings to the Gulf of Maine's carbon cycle will be discussed.

Jacobson, S., Cooperative Extension, University of Massachusetts, Boston, MA, and P. Kent, Town Hall, Ipswich, MA. SOFT SHELL CLAM (MYA ARENARIA) CULTURE: REPORT OF PROGRESS.

In response to depleted soft shell clam resources on the Mass. North Shore a pilot study was begun in 1987 to determine the feasibility of soft clam culture. Clams from nearby flats were planted at a density of 95/m² in sediments framed by boards and covered by 1/4 inch screen. The clams grew from a mean shell length (SL) of 30 mm to a mean SL of 41 mm from July 17 to Oct. 28. Survival ranged from 70 to 87% and was related to the presence of crabs (Carcinus) in the culture beds. Clams grown in beds raised 15 cm above surrounding sediments grew no faster than those in beds at grade level. Undercutting of raised beds by currents was controlled by banking gravel at the corners. The study will continue through 1988. These preliminary results suggest that softshell clams can be grown to legal size (51 mm SL) or greater in 2 to 2 1/2 years.

Kuzirian, A.M. Marine Biological Lab., Woods Hole, MA. J.P. Bidwell. Howard Hughes Medical Inst., Woods Hole Oceanographic Inst. and S.M. Gallager. Biology Dept. Woods Hole Oceanographic Inst. Woods Hole, MA. MOLLUSCAN MINERALIZATION IS DEPENDENT UPON STRONTIUM

Formation of normal calcified embryonic structures in opisthobranch and bivalve molluscs is dependent upon minimal levels of strontium in artificial seawater. Embryos reared in defined media lacking strontium fail to develop mineralized shells. Statolith granules in the statocysts also do not form in opisthobranchs. Soft tissue development appears normal in all cases but swimming behavior of animals without statoliths is erratic. Mineralization is sensitive to as little as 1 ppm with a level of 5-8 ppm being required for complete calcification.

A critical period of exposure is exhibited by Aplysia and Hermiggenida beginning at Day 4 and lasting <24 hrs. while in Mercenaria it occurs between Hours 15-20 of embryogenesis. For most species examined, exposure to strontium before and after the critical window fails to allow calcification. In Aplysia, however, exposure after Day 5 does produce some abnormally shelled animals. Current research on the possible mechanisms involved in this phenomenon will be presented.

List, James T., Manager, Wells National Estuarine Research Reserve, Wells, ME
WELLS NATIONAL ESTUARINE RESEARCH RESERVE

The WNERR protects nearly 2000 acres of wetland, upland, and beach along Wells Bay in southern Maine. The Reserve includes the wetlands and estuaries of the Webhannet and Little rivers, which drain into the sea between double barrier spits. Research is encouraged at the Reserve through grants. Funding priority is given to issues relating to water and sediment management, nutrients and other chemical inputs, biological productivity, and estuarine fishery habitat requirements.

The presentation will be a poster and self-contained audio-visual presentation about the Reserve.

Loder, T. C., Institute for the Study of Earth, Oceans, and Space, University of New Hampshire, Durham, NH 03824 NUTRIENT AND HYDROGRAPHIC PARAMETERS IN COASTAL WATERS OFF BOSTON HARBOR DURING LATE SUMMER - 1987.

Between July 15 and September 8, 1987, seven cruises were made in Broad Sound to determine secchi depth, salinity, temperature, dissolved oxygen, pH, and nutrients. Samples were also collected for plankton studies and primary productivity work. Three stations were occupied in Broad Sound and one station just inside Boston harbor. Thermocline depths ranged from about 5 to 15 m, increasing toward late summer. Secchi depths ranged from about 2.5 to 9 m and were quite variable both with time and location. The 3% light level was generally below the thermocline so productivity does occur below the surface mixed layer. Surface water salinities increased during the period from about 30.6 to 31.4 ppt, but remained stable in the bottom water. Dissolved oxygen in deep water dropped slowly from around 100% saturation to about 80% saturation. In general, all surface nutrient concentrations were lower in Broad Sound than in the harbor. Although most nutrients were quite variable in surface waters with local upwelling, they were often near zero concentration except phosphate. The parameters varied the most in the surface waters southeast of Nahant, and the least at a station near the large navigation buoy "B".

Lyons, W.B., M.E. Hines and H.E. Gaudette, Institute for the Study of Earth, Oceans and Space, and The Department of Earth Science, University of New Hampshire, Durham, NH.
A TALE OF THREE ESTUARIES QUALITATIVE EVALUATION OF BIOGEOCHEMICAL PROCESS IN ORGANIC RICH SEDIMENTS.

Our collective understanding of the microbial biogeochemistry of nearshore sediments has grown considerably in the past decade. Numerous studies have both qualified and quantified the microbial processes which affect the geochemistry of pore waters and the overall early diagenesis of sediments in this environment. Yet little attempt has been made to compare/contrast the importance of different types of microbial processes in coastal zone sediments from different climatic regions. In this talk we will compare estuarine pore water data from both brackish and more saline regions of three different estuarine systems: a northern temperate system in New Hampshire, a mid-latitude system in North Carolina, and a tropical system in Brazil. In general, these three estuaries have similar sediment types and organic matter content. Although it appears that sulfate reduction is the major biogeochemical process occurring in the saline part of all three systems, ferric iron reduction may be much more significant in the brackish portion of the tropical estuary than the other two systems. This is undoubtedly due to the increased supply of readily reducible Fe^{3+} to these sediments. In addition, we speculate that the form of Fe^{3+} being buried also influences iron reduction rates in these environments. Therefore, climate, in general, and the intensity of crustal weathering, in particular, may play a major role in determining the importance of sediment biogeochemistry processes in estuaries.

C.C. McIvor^r, L.P. Rozas², and W.E. Odum³. The Ecosystems Center, Marine Biological Laboratory, Woods Hole¹, Waterways Experiment Station, Vicksburg, Miss.², and University of Virginia³. AN ANALYSIS OF THE SELECTION OF MARSH SURFACE HABITAT BY FISHES IN A TIDAL FRESHWATER MARSH.

Fishes residing in tidal creeks at low tide gain access to marsh surface habitat on the flood tide via 2 types of corridors; via rivulets, or across undissected creekbanks. Creekbanks are of 2 types, either shallow depositional, or steep erosional. We sampled fishes entering marsh surface habitat with flume nets between June and October 1986 to determine whether fishes preferentially use rivulets as corridors to the marsh surface. The mean number of fishes collected in rivulets was 3 times greater, and the mean biomass 14 times greater than those collected at depositional creekbank habitat. By estimating the abundance of all three types of habitat in our study area, we determined the relative importance of these 3 corridors for fishes. We estimate that rivulets occupy only 3% of the area along our creeks but admit 12% of the fishes to the marsh surface. Most fishes gain access to the marsh surface across depositional creekbanks.

Michener, R. H., M. I. Scranton and P. C. Novelli, Marine Sciences Research Center, State University of New York at Stony Brook, Stony Brook, New York. HYDROGEN VARIATIONS WITHIN THE ANOXIC SEDIMENTS OF AN ESTUARY.

Hydrogen is an important intermediate in the catabolic reactions involved with organic carbon remineralization. We have developed a sensitive method for determining hydrogen which has been applied to the sediments of the Carmans River Estuary, Long Island, NY. The trends in methane and sulfate porewater concentrations in the estuary suggest a shift in metabolic processes from methanogenesis to sulfate reduction as salinity increases. A simultaneously collected transect of hydrogen profiles show a trend of decreasing concentrations with increasing salinity. Marine hydrogen concentrations averaged 30 nM, while freshwater hydrogen concentrations ranged from 50-300 nM. We hypothesize that, because of competition between sulfate reducers and methanogens for hydrogen, the change in hydrogen concentrations is associated with the shift in metabolic processes within the anoxic sediments of the estuary.

Moore, J.K., Department of Biology, Salem State College, Salem, MA 01970

BEHAVIORAL EVOLUTION OF ESTUARINE RESEARCH SOCIETIES IN NEW ENGLAND

The turnover of membership in NEERS is large due to a number of factors, very few of which are worth discussing. The present organization maintains a rich history which is bound to be lost without notice. Analysis of past meetings suggests that we disband and reconvene as a drinking society.

Murray, S. and J.W. Soules, Dept. of Environmental Protection, State of Maine, Augusta, ME.

MARINE ENVIRONMENTAL MONITORING PROGRAM - PRELIMINARY RESULTS FROM BOOTHBAY HARBOR, MAINE.

A long term ambient monitoring program for Maine's coastal areas began in July, 1986 in Boothbay Harbor. Mussel tissue and surface subtidal sediment samples collected in four areas of the harbor have been analyzed for "total" Hg, Pb, Cd, Ni, Zn, Cu and Cr. Sediment metal concentrations (ug/g) are corrected for differences in sediment type by normalizing to surface area (ug/m²). Sediment metal concentrations in excess of background levels (Pb, Cu, Zn, Hg) are probably due to point and non-point sources. Tissue metal concentrations indicate current pollution problems for lead. Ongoing project goals include organic contaminant analysis and evaluation of benthic community structure.

Orson R. A. and B. Howes. Center for Coastal and Environmental Studies, Rutgers University, New Brunswick, New Jersey 08903 and Woods Hole Oceanographic Institute, Woods Hole Massachusetts 02543. BRACKISH INTRUSION AND WETLAND DEVELOPMENT AT WAQUOIT BAY, CAPE COD, MASSACHUSETTS.

The brackish intrusion and development of tidal wetlands was investigated for Waquoit Bay. Interpretation of results are based on the percent species composition of roots and rhizomes and sedimentological characteristics preserved in the marsh substrate, basal topography profiles and present day plant community structure. The system began as a swamp/forest complex over 6 meters ago. As sea levels rose and ground water tables increased a sedge/*Typha* transition zone replaced wooded areas. This transition zone begins at about 2.3 meters and in many areas extends over 0.5 meters in time. The first true salt marsh signature begins at 1.75 meters along both Great River and Hamblin Pond transects. It is hypothesized that both Hamblin Pond and Great River were connected in the past and that both system may have drained directly into Waquoit Bay above its present opening. A clay band is present in 60% of the cores at 0.13 meters and may represent a storm event. Historic vegetation changes preserved within the peat record does mirror present day vegetation changes as one moves up estuary.

Pregnull, A. Marshall and Nina C. Roth, Biology Department, Vassar College. Poughkeepsie, NY
NITRATE REDUCTASE ACTIVITY IN *ZOSTERA MARINA* (EELGRASS)

While eelgrass plants appear to obtain most of their nitrogen as ammonium from sediments, the leaves have access to nitrogen in the water column as well. We assessed the potential for use of nitrate by eelgrass by measuring nitrate reductase (NR) activity. A comparison between roots and leaves of different ages indicates that younger leaves have much higher NR activity than roots or older leaves. Plants growing at the shallow edge (0.8 m) of one eelgrass meadow have much higher NR activity than plants growing at depth. However, comparison with plants collected at two other field sites suggests that neither shallow growing depth nor peripheral meadow position are responsible for the elevated activity. Six day nitrate enrichment experiments indicate that some shallow growing plants can increase NR activity. Water column nitrate levels were higher at the shallow-edge collection site than at the two other collection sites, suggesting that localized nitrate input from surface runoff or groundwater input may be sufficient to induce NR activity in eelgrass leaves.

Pyott, C.P., Dept. of Earth Sciences, Univ. of New Hampshire, Durham, New Hampshire, 03824. HYDROLOGIC AND NUTRIENT FLUX COMPARISON OF SPARTINA PATENS AND PANNE ZONES OF BASS BEACH MARSH, NORTH HAMPTON, NEW HAMPSHIRE.

The continued development of coastal New England is causing increased disruption of natural tidal flooding, through flood control features such as tide gates and culverts. At Bass Beach Marsh, a 15 ha salt marsh in North Hampton, NH, a restricting culvert is causing enhanced inundation of tidal water. In some areas of Bass Beach, panne areas have resulted, consisting of blue green algal mats covering dead Spartina patens. In the summer of 1987, experiments comparing the hydrology and nutrient cycling processes which occur in the panne areas and healthy Spartina patens areas were conducted in this marsh. Data from each of the areas will be compared.

Rhodes, Kathleen Smith, University of Connecticut Sea Grant, 670 Wintergreen Avenue, Hamden, CT 06514.

THE LONG ISLAND SOUND STUDY, AN OVERVIEW.

The Long Island Sound Study is a large, bi-state research effort which will produce a management plan designed to preserve Long Island Sound. The Study, federally funded through the U.S. Environmental Protection Agency as part of the National Estuary Program, is now in its third year of a projected five years of annual funding of from one to two million dollars. The most important difference between the Long Island Sound Study and previous studies is that the end product will be a management plan whose implementation has been anticipated. Unprecedented cooperation among the researchers has meant efficient use of ship time and the collection of data directly relevant to several research projects. to the hydrographic computer model and ultimately to the management plan. Additionally, there has been an outstanding effort to have all the groups involved in the Sound play a part in directing the research. This coordination will result in a good management plan which addresses the concerns of the people who use the sound and will be supported by the many who contributed to it.

Roman, C.T.¹, K.W. Able², K.L. Heck³, M.P. Fahay⁴, J.N. Portnoy⁵, and M.A. Lazzari¹.
¹NPS Cooperative Research Unit, Rutgers U., New Brunswick, NJ, ²Center for Coastal and Environmental Studies, Rutgers U., ³Dauphin Is. Sea Lab, AL, ⁴NMFS, Sandy Nook, NJ, ⁵NPS, So. Wellfleet, MA. HABITAT ECOLOGY OF NAUSET MARSH (CAPE COD NATIONAL SEASHORE).

A 3-yr study was initiated in July 1985 to obtain a quantitative ecological data base and an understanding of the functional ecology of the 950-ha Nauset Marsh system. Considering the ongoing growth and development on outer Cape Cod, the National Park Service recognized the need for obtaining baseline data so that impacts could be effectively detected and appropriate 'action implemented. This study evaluates numerous habitats (salt marsh, eelgrass beds, intertidal mudflats, sand bottoms, tidal channels) and includes, primary production and biomass estimates, assessment of fish, decapod crustaceans, macrobenthos and birds, hydrodynamics, and nutrient interaction studies. This paper highlights aspects of the study which will improve our understanding of the nursery role of New England salt marshes and the interaction of diverse habitats within salt marsh-estuarine systems.

Huber, L. , Gilbert, A., Cummings, E , and G. Gillis, Biology Department, Northeastern University, Boston, Mass. MICROCRUSTACEA OF THE ARTIFICIAL. COASTAL IMPOUNDMENTS OF NEW JERSEY AID THE NATURAL SALT MARSH POOLS OF MASSACHUSETTS.

Microcrustacean populations were followed for three years in fresh and salt coastal impoundments constructed for mosquito control and fish and game enhancement in New Jersey. In Massachusetts, populations were followed for 1 year at a time as a part of three separate studies, each designed for a different purpose. Population trends as correlated with salinity, temperature, and season are summarized. Three groups, freshwater, salt marsh and bay species are identified. Microcrustacean production trends in the coastal impoundments are summarized.

T.J. SMAYDA and T.A. VILLAREAL, GSO, Univ. Rhode Island, Kingston, R.I. 02881. ENRICHMENT EXPERIMENTS AND POTENTIAL INFLUENCE OF SILICON ON NUTRIFICATION IN COASTAL WATERS OFF BOSTON HARBOR DURING LATE SUMMER 1987.

Nutrient-spike experiments evaluated the effect of various concentrations of N+P and N+P+Si on phytoplankton biomass, growth rate and primary production. N+P+Si enrichments were more stimulatory than N+P enrichments. A kinetics experiment showed a highly significant yield-dose relationship between chlorophyll production and initial NH_4 concentrations ($Y=5.17X^{0.62}$; r^2 0.94), and between chlorophyll yield and NH_4 uptake ($Y = 3.33 \cdot 2.06X$; r^2 0.85). NH_4 uptake was significantly correlated with its concentration; the relationship being influenced by SiO_2 . At $>12.5 \text{ mg-at } \text{NH}_4 \text{ m}^{-3}$, SiO_2 in excess of $5 \text{ mg-at } \text{m}^{-3}$ stimulated NH_4 uptake by 60% ($r^2 = 0.98$). Below $5.0 \text{ mg-at } \text{m}^{-3} \text{ SiO}_2$, $Y = 0.93X^{0.91}$ ($r^2 = 0.89$). Between 5.0 and $18.5 \text{ mg-at } \text{m}^{-3} \text{ NH}_4$, $\geq 90\%$ of the NH_4 was taken up over a 48-hr period. Above $18.5 \text{ mg-at } \text{m}^{-3} \text{ NH}_4$, the percentage uptake fell off rapidly, but was still influenced by SiO_2 concentration. This apparent influence of SiO_2 on various phytoplankton responses to nitrogen enrichment was unexpected. The potential role of SiO_2 as a mediator of phytoplankton community responses to estuarine nitrification warrants further study.

**SPECIAL SYMPOSIUM ON
COASTAL PONDS & LAGOONS
ABSTRACTS OF PAPERS**

Anderson, D. M., and B. A. Kcaler, Biology Department , Woods Hole Oceanographic Institution, Woods Hole, Massachusetts 02543
DINOFLAGELLATE SPECIES SUCCESSION IN A COASTAL POND: MECHANISMS AND DYNAMICS.

Coastal ponds on Cape Cod often are dominated by dinoflagellates. The numerous species bloom in a bewildering sequence throughout the year that only begins to make sense when the species are grouped together under three general strategies: a) cyst-forming species; b) those purely-planktonic species that are endemic and eurythermal; and c) those that are introduced to the pond by advection. Differences in the low temperature threshold for germination and the duration of the maturation period after cyst formation cause the blooms of cyst-forming species to occur in a consistent sequence. Although the magnitude of the blooms of the dinoflagellates depend upon environmental and nutritional factors in the plankton, the general temporal sequence of species can now be explained and predicted.

Buckland, K.J., Planning Board, Town of Falmouth, MA
Scientific Certainty vs Regulatory Needs: The case of Nutrient standards for Coastal Ponds.
Falmouth adopted regulations in 1984 called the Nutrient Loading Bylaw. These regulations require a determination of the levels of both the project site and total recharge area of loading of phosphorous and nitrogen compounds into the ground water and/or receiving open water body. The results of these assessments have been used to restrict or negotiate changes in development projects, and as a broader planning tool for managing inland and coastal ponds. However, the nitrogen standards for coastal ponds, listed as a maximum 0.75 mg/l) have remained controversial. The attempts to resolve differences between scientific certainty and regulatory needs are discussed.

Caraco, N. F. Institute of Ecosystem Studies, Millbrook, N.Y.
RELATIONSHIP BETWEEN PRODUCTION AND NUTRIENT LOADING IN A BRACKISH COASTAL POND, SIDERS POND, FALMOUTH MASSACHUSETTS.

Eutrophication is a serious problem in coastal ponds. Despite this we do not have the data to quantify the relationship between nutrient loading and trophic state in these systems. Such empirical models, which have already been developed for fresh-waters, would be extremely useful in managing coastal ponds.

Data is presented on the production, water transparency, chlorophyll, and nutrient concentrations in one coastal pond. Using empirical models developed for fresh-water systems, these trophic indicators were accurately predicted from estimates of nutrient loading. This, and similar results in the Potomac Estuary, suggest that these fresh-water derived models may be able to be directly used or modified slightly for use in managing brackish systems.

Costa, J. E., Boston University Marine Program, Marine Biological Laboratory, Woods Hole, MA.

RECENT AND HISTORICAL CHANGES IN ABUNDANCE OF EELGRASS (*Zostera marina* L.) IN WAQUOIT BAY, MA.

Changes in eelgrass (*Zostera marina* L.) abundance in Waquoit Bay, a lagoon on Cape Cod, were documented with aerial photographs, sediment cores, and firsthand accounts. Because eelgrass seed deposition reflects local abundance, seeds in sediment cores were used to document historical changes in eelgrass cover. Four cores were dated using the 1931-32 wasting disease seed decline and other biogenic markers. Seed profiles in near-surface sediments coincide with changing eelgrass cover in the photographic record. Carbon stable isotope ratios ($\delta^{13}\text{C}$) in core sediments are also generally consistent with historical changes. Eelgrass declined in Waquoit Bay during 3 periods in this century: during the wasting disease, ca. 1904, and during 1965-75. The 1904 decline coincides with a report of an earlier outbreak of disease. The most recent decline (>80% loss) coincides with human disturbance and nutrient loading. Today dense layers of benthic drift algae cover most substrate where eelgrass once grew. The primary mechanism of this decline appears to be decreased light availability to eelgrass because of increased water turbidity and increased algal epiphytes from added nutrients.

Deegan, L.A., S. Saucerman, and D. Basler. Dept. of Forestry and Wildlife Management, University of Massachusetts, Amherst, Ma.,
CHANGE IN THE WAQUOIT BAY FISH COMMUNITY OVER A TWENTY YEAR PERIOD

We have examined changes in the fish structure of Waquoit Bay over the last twenty years by comparing new data to a 1966 survey. Although we have not yet finished a full years sampling we have observed some striking changes in fish abundances. Only 5 species increased in abundance; all the rest decreased. The most dramatic change is a 6000% increase in rainwater killifish. This increase may be due to its preference for filamentous algae as spawning and feeding areas. Large areas of Waquoit are now covered in filamentous algae presumably as a result of nutrient loading. Of the fish that decrease in abundance, fish with an estuarine dependent life-history declined the most. We believe this is because of the decline in eelgrass habitat. We suggest that eutrophication has caused changes in the quality of the estuary as a nursery and feeding area.

FitzGerald, D.M., Department of Geology, Boston University, Boston, MA.
Formation And Fate of Coastal Bays and Tidal Inlets in New England.

Pleistocene glaciation together with Holocene erosional and depositional processes have formed numerous tidal inlets and embayments along the coast of New England. Most of these systems are fronted by sandy barriers and are kept open by tidal currents. Despite rising sea level, many of the bays are filling due to: 1. storm overwash, 2. flood tidal currents, 3. aeolian deposition, and 4. sediments washed into the bay from the surrounding uplands. Through time, these sedimentation processes have caused a decrease in the size of the bays and a coincident decrease in the bay tidal prism. This has resulted in smaller tidal inlets and in some cases inlet closure. The closure of tidal inlets occurs when bays reach a critical size, such that, tidal currents filling and emptying the bay are no longer sufficient to remove sand that is transported into the inlet channel by wave action. Factors controlling size and ultimate fate of tidal inlets include the area of the bay, tidal range, wave energy, and sediment supply. The micro-tidal new and small bays of the Rhode Island, Buzzards Bay and Nantucket Sound shorelines, have produced small tidal inlets, which in many cases, require engineering structures to keep them open.

Gaines, A.G., Jr. Marine Policy Center. Woods Hole Oceanographic Institution. Woods Hole, Mass. PERSPECTIVES ON SCIENCE AND MANAGEMENT IN SOUTHERN NEW ENGLAND ESTUARIES.

The flooded glacial coast of southern New England provides the opportunity to compare estuaries of varied geometry, tidal forcing, freshwater input and anthropogenic impact. Observation of several of these estuaries suggest the generalizations sought by managers and legislators to serve as a basis for standards, regulations and estuarine "health" Indices are less straight forward than commonly believed. Examples treating dissolved oxygen, littoral drift, nutrient loading and eutrophication are discussed.

Kerfoot, V. B., K-V Associates, Inc., Falmouth, MA.
FIVE YEARS UNDER SAIL - EXPERIENCES WITH THE NUTRIENT BYLAWS.

In 1982, the Planning Office of the Town of Falmouth commissioned K-V Associates to prepare a cumulative impact procedure for assessing development in vital resource areas. The regions were defined as recharge zones for municipal supply wells, freshwater kettle ponds and salt ponds. The approach involved defining the carrying capacity for the receiving waters based upon best available scientific information and then computing backwards to the nonpoint source contribution from each land surface area to be developed. Originally, the saltwater standards were based upon fresh water guidelines projected from the Dillon-Vollenweider Lake approaches. The past few years have strengthened the basis for the marine water proposed critical level. Fish kill events in Barites Pond and Green Pond have established the undesirability of exceeding the total mean total nitrogen level of .150 mg/l (ppml). A staple model was also developed to allow evaluation of denitrification from fringe marsh regions of salt ponds. New challenges appear to lie in dealing with salt pond regions where saturation development will exceed the carrying capacity of the water body. Choices of remedial action are presented and discussed. Should action standards be critical limits or be changed to recreational limits to avoid "designing for failure"?

Lee, V. Coastal Resources Center, GSO, Univ. Rhode Island, Narragansett, RI.
EUTROPHICATION, SCIENTIFIC RESEARCH AND MANAGEMENT INITIATIVES FOR RHODE ISLAND COASTAL LAGOONS

Coastal lagoons, locally known as salt ponds, are an important feature along Rhode Island's ocean shore. They are highly productive systems supporting commercial and recreational fin and shellfisheries as well as intense recreational use. Their shoreline is the drawing card for an unprecedented rate of residential and commercial development within their watersheds. The water quality impacts of this development have been documented by a multidisciplinary University of Rhode Island research program and more recently by a volunteer citizen monitoring project. The results of the research have been incorporated into state and local government regulations designed to curtail excessive nutrient and bacteria loadings.

Short, F T , E C Brainard, and J Wolf. Jackson Estuarine Laboratory, University of New Hampshire, Durham, NH EAST COAST EELGRASS POPULATIONS LATITUDINAL TRENDS AND HEALTH ASSESSMENT

We designed an experimental program to examine eelgrass populations latitudinally in National Estuarine Research Reserve sites from New Hampshire to North Carolina, hypothesizing that eelgrass growth, abundance, and plant morphometrics show latitudinal variations distinct from the health of plant populations related to coastal pollution and wasting disease. Sites were selected at each of four Research Reserves for similar environmental characteristics of light, mean depth, temperature, current velocities and sediment type, while factors of salinity and tidal variation differed between sites. Eelgrass samples collected in July at all sites showed strong trends with latitude. Eelgrass leaf abundance and shoot size were greatest in the north and showed a consistent decrease, the minimum occurring in North Carolina. Eelgrass health did not show latitudinal trends. Rather, pollution levels and the extent of wasting disease at each Research Reserve site combined to determine plant health. Waquoit Bay eelgrass showed evidence of light stress, the apparent result of nutrient pollution. All sites showed evidence of the expanding eelgrass wasting disease, with the greatest impact in Great Bay, New Hampshire

Spaulding, M.L., Ocean Engineering, University of Rhode Island, Kingston, R. I. 02881
TIDAL EXCHANGE BETWEEN BLOCK ISLAND SOUND AND NINIGRET POND

A field program was performed to determine *the* exchange of water between Ninigret Pond and Block Island Sound (BIS) at tidal and subtidal frequencies. Time series on sea level variations in BIS and Ninigret Pond, spatially integrated velocities across the breachway connecting the two (obtained by a GEK) and wind speed and direction were collected from April 21 - June 3, 1980. A hybrid hydrodynamic model incorporating a simplified one dimensional approximation for the breachway channel systems and a two dimensional approximation for the breachway channel systems and a triangular grids for the pond proper was used to model the ponds' response to ocean forcing. Model predictions were in good agreement with the field data. Both show a factor of 5.5 reduction in the semidiurnal tidal amplitude, and a high water shift of 2.5 hrs., relative to BIS.

Teal, J. K. and B. L. Howes. Woods Hole Oceanographic Institution, Woods Hole, MA 02543.
NITROGEN BUDGET OF A CRANBERRY BOG

Cranberry bogs are the most extensive type of agriculture in southeastern Massachusetts. Bogs are usually associated with streams which flow directly into coastal ponds and embayments. Bogs are fertilized throughout the growing season and are occasionally flooded and drain into these streams. Portions of the bogs function as permanent freshwater wetlands and can be responsible for significant amounts of nitrogen retention release. So cranberry bogs have the potential to be either a source or a sink for nutrient runoff and may contribute to or aid in the control of coastal eutrophication. We have continuously measured inputs and outputs of water and nutrients from one bog system throughout one year. We have measurements of nitrogen exchanges between the water and sediments of the bog creeks and vegetated surface. We also have measurements of dissolved nitrogen concentrations in porewater. With these data and data on plants, fertilization, and harvest we have constructed an annual nitrogen balance for a cranberry bog system.

Valiela, I., and J. Costa. Boston Univ. Marine Program, Marine Biological Laboratory, Woods Hole, MA

N AND P INPUTS INTO BUTTERMILK BAY AND ITS WATERSHED

To evaluate the relative importance of various sources we estimated inputs of nutrients into the watershed and into the Bay itself. Septic systems contributed about half the nitrogen and phosphorus entering the watershed, with precipitation and fertilizer use adding the remainder. Groundwater transported over 85% of the nitrogen and 75% of the phosphorus entering the Bay. Uptake by forests, soils, denitrification, and adsorption intercept two-thirds of the nitrogen and nine tenths of the phosphorus that entered the watershed; most nutrients entering the watershed thus failed to reach the Bay. Nitrogen reaching the Bay most likely originates from subsoil injections into groundwater by septic tanks, plus some leaching of domestic fertilizers.

Buttermilk Bay water contains relatively low nutrients, probably because of uptake by macrophytes, and relatively rapid tidal flushing. Nutrients entering the watershed have a N/P of 6, but passage through the watershed raises N/P to 23, probably because of adsorption of PO_4 in transit. Urbanization of watersheds further increases loadings to nearshore environments, and shifts nutrient loadings delivered to coastal waters to relatively higher N/P, potentially stimulating growth of nitrogen limited primary producers.