

New England Estuarine Research Society

FALL MEETING

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Best Western Stagecoach Inn

Kittery, Maine

HOST

University of New Hampshire's

Department of

Earth Sciences

Marine Program

Ocean Process Analysis Laboratory

ABSTRACTS

EFFECTS OF DISTURBANCE ON A MUDFLAT COMMUNITY
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The effects of disturbance on benthic communities have been studied by many investigators. Few, however, have focused their research on the intertidal soft-bottom benthos of northern New England. In Jonesboro, Maine, the effects of the ongoing disturbance of clamdigging were compared to those of the artificial disturbance created by treatments applied to a mudflat for the purpose of enhancing recruitment of Mya arenaria. The effects of these disturbances were then compared to the overwhelming natural disturbance of the ice and sub-zero temperatures of winter.

NEW EPIFLUORESCENT AND MICROPLANIMETRY TECHNIQUES FOR THE STUDY OF
EPIPELIC DIATOM COMMUNITY ORGANIZATION IN ESTUARINE SEDIMENTS

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Several unusual techniques were used to investigate the vertical microspatial organization of epipellic diatoms in intertidal estuarine surface sediments. Small undisturbed sediment cores were collected at low tide and returned to the laboratory. Cover slips were gently inserted vertically into the sediment and the cores were incubated overnight to allow the algal cells to attach to the glass and migrate to their preferred positions at various depths in the sediment. The cover slips were then removed and vertical profiles (from the interface to a depth of 1-2mm) were photographed under an epifluorescence microscope. The resulting photomicrographs were analyzed by computerized planimetry: the slides were projected onto a graphics tablet and cell sizes (in terms of chloroplast area) were measured by electronically planimetrying the autofluorescing diatom cells.

These techniques showed that the diatom assemblage was vertically stratified by cell size over micro-distances. Small rapidly dividing naviculoid cells were concentrated at the interface. Larger highly motile sigmoid forms were concentrated in mucilagenous masses somewhat deeper in the sediments. The depth of this stratification pattern varied from 100um to 2mm but the organization of cells according to size was highly consistent. Although species distributions are known to change seasonally in intertidal sediments, cell size stratification was consistent throughout the year.

NOTES ON THE TEMPORAL AND SPATIAL DISTRIBUTION OF THE DIFFERENT
STAGES OF AN ESTUARINE POPULATION OF CYANEA: A PROGRESS REPORT

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Little is known of the population ecology of jellyfish despite their nearly ubiquitous presence in the shallow marine environment, and the gradual recognition that their local abundance and predatory habits must influence the communities of which they are a part. To begin to fill this void for one relatively circumscribed population, I have made observations of the pelagic and benthic stages of Cyanea in the Niantic River (CT) for several years. The occurrence of the pelagic medusa stage is generally predictable from year to year: they first appear about the end of March, become sexually mature in early May, begin to reproduce during mid-May, and continue to do so until they disappear the first week of July; during the last three weeks of their reproductive period the medusae are in a deteriorated condition. The onset of reproduction appears to be temperature related and is apparently independent of age (?) and/or size of the medusa; sex ratios approximate unity (1.10 males:1.00 females; n=428). A mature 10 cm diameter female can produce at least 5.2×10^6 eggs, and in general the egg number/size relationship is expressed by the regression, $Y = -453 + 97X$, where X is the diameter in cm. The pelagic medusa stage is linked to the benthic stages by the planula larvae they produce. The planulae attach and encyst on shell surfaces oriented toward the substrate (99%) and occur on 5% of the shells dredged from the bottom during the period of reproduction; 70% of the planulae attach to shells not occupied by polyps (or podocysts) from the previous generation(s). The ratio of podocysts to polyps is about 2:1. The polyp stage disappears in August and is represented only by the podocysts it produces; this, and the encysted planula, are the only stages present during the warmer period of the year. Records of the encystment of these stages and the asexual reproduction of the ensuing polyps which produce the ephyra stage during the cooler weeks (leading the following spring to a new generation of medusae) are in progress.

ZOOPLANKTON STUDIES IN CORNWALLIS RIVER, NOVA SCOTIA

Gail Brown, Department of Biology, Acadia University

Cornwallis River is an extremely turbid estuary tidal in its lower reaches. Turbulence created by the ebb and flow of twice daily 15 m tides generating currents in the vicinity of 3 to 5 kts ensures that the estuary remains vertically mixed. It meanders through some of the richest agricultural land in Nova Scotia emptying into Minas Basin, site of the proposed Fundy tidal power project. Zooplankton samples collected in November 1980 indicated an unexpectedly high abundance of many organisms, particularly the calanoid copepod Eurytemora herdmani and several species of harpacticoid copepods. It was therefore decided to establish a regular sampling program in order to study seasonal and possibly tidal variation in numbers and species of zooplankton.

Sampling is conducted weekly at high tide and every two weeks over two consecutive tidal cycles. In addition, concurrent analyses of temperature, salinity, current speed, chlorophyll activity and several inorganic nutrients are being-carried out. Field work is expected to continue until May 1982.

Tidal rivers such as the Cornwallis have many unique aspects and special problems associated with sampling procedures and quantitative analyses of samples will be discussed.

In view of the importance of estuaries as nursery grounds for juvenile marine fish, it is hoped this study will contribute valuable information on the ecology of Minas Basin prior to the construction of a tidal power barrier.

DISTRIBUTION AND ACTIVITY OF SUSPENDED BACTERIA IN THE BAY OF FUNDY

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Spring, summer and fall cruises through the Bay of Fundy showed that free-living bacteria generally dominated near the mouth of the Bay, while attached bacteria dominated in the upper reaches; total counts ranged from 0.2 to 4.0 x 10⁶ cells ml⁻¹. Heterotrophic activity measurements with ¹⁴C-glutamic acid showed that on a per cell basis free-living bacteria were relatively more active in summer, and attached bacteria in fall; the proportion of total activity by attached cells increased with substrate concentration.

RELATIONSHIPS BETWEEN SALT MARSH AND ESTUARINE BACTERIAL POPULATIONS

Richard B. Coffin and Richard P. Wright, Gordon College

Previous examination of bacterioplankton numbers and activity in the Essex River estuary in Northern Massachusetts revealed a pronounced mid-estuarine peak in numbers and activity, which developed with warm weather and disappeared by December. Subsequent studies compared the DOC and bacteria concentrations of the Essex, Ipswich, and Parker River estuaries after a long flood tide series and the following neap tide series. Results indicated that dissolved organic material washed from Spartina during the flood tide fueled a bacterial growth response whose magnitude corresponded directly to the salt marsh area of each river. Further laboratory experimentation demonstrated that Spartina exudate could be used to enrich a bacterial population. It was concluded that dissolved organic Spartina exudate contributes to estuarine bacterioplankton metabolism and is responsible for the mid-estuarine peak in bacteria.

SEASONAL VARIATIONS IN HEMATOLOGY OF THE WINDOWPANE FLOUNDER,
SCOPHTHALMUS AQUOSUS, AT THREE STATIONS IN LONG ISLAND SOUND, USA

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The valid interpretation of hematological data for fish often depends on distinguishing changes that are the result of a particular stress under study from those attributable to natural conditions, such as temperature and salinity. We are attempting to distinguish seasonal variations in hematology from those produced by pollution by sampling at short intervals in a clearly defined and limited body of water. Blood samples from windowpane flounder, Scophthalmus aquosus, are being collected monthly at three stations in Long Island Sound: Station 90, off Roanoke Pt., Long Island (40°58'51"N x 72°45'00"W), a relatively clean area as measured by analyses of sediment metal levels; Station 54, off Milford, CT (41°09'01"N x 73°00'00"W), a moderately polluted area; and Station 9, Hempstead Harbor, NY (40°53'50"N x 73°40'90"W), a very polluted area. Two-way analysis of variance indicates that significant variation can be attributed to months for all hematological parameters measured, namely, hematocrit, hemoglobin, plasma osmolality sodium, potassium, and calcium. Station location had significant effects on hematocrit, osmolality, sodium, and calcium, but not on hemoglobin or potassium.

Monthly sampling is being supplemented by a series of laboratory exposures of the same flounder species to heavy metals. Following exposure to, low levels (5 and 10 ppb) of mercury for 60 days, there were no significant changes in hematocrit or hemoglobin, but sodium and calcium changed significantly. Exposure to cadmium produced a change in calcium only. This is a continuing study; the results should provide a solid base for comparison of much of the hematological data collected on our major cruises in coastal U.S. Atlantic waters.

AN INITIAL ATTEMPT TO DEMONSTRATE IMPACT OF FUNDULUS
HETEROCLITUS ON SALT MARSH COPEPODS IN THE FIELD

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Attempts to measure directly the impact of predatory fish on prey populations is difficult especially when the prey are not sessile species. This talk describes an experiment in which the salt marsh mudflat Fundulus heteroclitus is observed in natural high salt marsh pools and is shown to have an immediately measurable impact on localized copepod populations.

A shallow inlet of a large panne pool was selected as the study site. Using a column sampler designed at Northeastern University, thirteen initial samples were taken near fixed points of reference. With the aid of volunteer observers times were noted when Fundulus heteroclitus entered and left a reference site. Immediately after the fish left an area a sample was taken. Control sites were sampled periodically throughout the day. Data will be presented showing a measurable impact on copepod numbers.

PROBLEMS IN IDENTIFYING COHORTS OF LARVAL HERRING, CLUPEA HARENGUS L.,
IN MAINE ESTUARIES AND EMBAYMENTS

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Hatching cohorts of larval herring were identified from the Sheepscot River estuary and Sullivan Harbor of Maine by estimating hatching dates from ring counts of their otoliths. However, only a third (545) of the larval otoliths examined were readable. The large number of unreadable otoliths was apparently related to the hours the larvae spent in the overnight sets of nets before their removal at dawn. The larvae were captured in buoyed and anchored nets set at dusk and retrieved at dawn during the period Sept., 1980-Feb., 1981. Some ways of relieving the problem are considered.

SEDIMENT SURFACE AREA: AN IMPORTANT PARAMETER IN MUDFLAT ECOLOGY

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University of New Hampshire and Department of Geology, University of Maine

Seasonal measurements of the Hydrolyzable Amino Nitrogen (HAN) content and specific surface area (m^2/g) of surficial sediments were made for 56 sites in a small intertidal mudflat in central coastal Maine. A strong linear relationship between the two parameters was noted at all times of year, though the slope to the line relating the two varied seasonally. Microbial colonization of fecal material expelled by suspension feeders is thought to account for the higher HAN content of the fine-grained sediments. Environments lacking a substantial filter-feeding community do not exhibit HAN enrichment of fine-grained sediments.

HISTOPATHOLOGY OF WINTER FLOUNDER (*PSEUDOPLEURONECTES AMERICANUS*) LIVERS FROM PLYMOUTH HARBOR AND BOSTON HARBOR, MASSACHUSETTS

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Livers of 13 winter flounder from Plymouth Harbor and 13 from Boston Harbor collected during one week in August, 1981, were examined histologically. Most livers showed some abnormalities, although not all livers showed the same set of pathological conditions. Abnormalities noted included focal areas of hepatocyte degeneration, degeneration or red blood cells, vascular stasis, hemorrhagic areas, fibrosis, and hepatocyte vacuolation. The principal difference between the livers from Plymouth Harbor and Boston Harbor was the increased vacuolation of hepatocytes in those livers from Plymouth Harbor collected in Boston Harbor. Only one of the 13 Plymouth Harbor fish showed an unusually large amount of hepatocyte vacuolation while 10 of the 13 Boston Harbor fish showed that condition. It is thought that the vacuolated cells contained large amounts of lipids.

SPRING TURNOVER IN THE SEDIMENTS OF GREAT BAY ESTUARY, N.H.

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Previous geochemical studies suggested that sediments in the Great Bay estuary, N.H. undergo a dynamic chain of bio-geochemical events during the spring. To further characterize these processes, spring samples of the upper 12 cm of sediment were collected from two sites and analyzed for glucose turnover, sulfate reduction rate, dissolved organic compound (DOC), titration alkalinity, dissolved iron, and acid volatile sulfides.

Temporal variations were interrelated through redox mediated dissolution and precipitation reactions and bioturbation. The results suggested the following scenario: in late March and April, heterotrophic activity increased with temperature, consumed DOC and indirectly caused the dissolution of iron by lowering sediment Eh. Sulfate reduction rates remained slow. Increased sulfate reduction in May slowly removed iron as sulfide minerals, while increasing DOC and alkalinity. Active bioturbation commenced in early June and was accompanied by rapid increases in glucose turnover and sulfate reduction, a 5-fold increase in dissolved iron and decreases in DOC and alkalinity.

The combination of microfloral and macrofaunal activities caused a rapidly changing oscillation in the chemical characteristics of the sediments. These interrelations appeared to increase the ability of the sediments to decompose organic matter and recycle nutrients. Our studies will be expanded during the spring of 1982 to include the effects of these events on trace metal concentrations and speciation and the possible role of denitrification.

RECRUITMENT OF SOFT-SHELL CLAMS (MYA ARENARIA) ON INTERTIDAL
FLATS FACING A BOAT CHANNEL

Thomas Hruby, Massachusetts Audubon Society

Adult soft-shell clams (Mya arenaria) are absent from intertidal flats which slope toward the ship channel in the Annisquam River, Gloucester, Massachusetts. Local clammers attribute this to turbulence from boat wakes, which, they claim, inhibits the recruitment of young clams. Preliminary results of studies carried out in the River indicate that this hypothesis may be valid.

In 1980 and 1981 the densities of young clams (8mm) were consistently low on flats which faced the boat channel with a slope of more than 1°. The highest density found at 15 exposed sites was 192 young clams/m², whereas in 40 sheltered sites, the highest densities ranged between 1000-2000/m². On three different flats which had areas that were both exposed and sheltered from boat wakes, significantly fewer young clams were counted on the exposed slope, and in one case the densities varied by a factor of 17 between exposed and sheltered sites 15m from each other. The surface sediments on the exposed flats were sandier than in sheltered areas, but when samples of these sediments were transferred out of the turbulence zone, colonization by clams was rapid. Within a week, the mean densities of young clams in 5 samples was 2200/m², while the same sediments on the exposed site contained only 142 clams/m².

ZOOPLANKTON EXCRETION: A BIOCHEMICAL APPROACH

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(No Abstract)

NECTONEMA (NEMATOMORPHA: NECTONEMATOIDEA) A PARASITE OF DECAPOD
CRUSTACEA IN THE BAY OF FUNDY

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Juvenile stages of the marine nematomorph genus Nectonema were found in the rock crab, Cancer irroratus, Jonah crab, C. borealis, hermit crab, Pagurus acadianus, and the shrimps, Pandalus montagui and P. borealis, in the Bay of Fundy. No effects on the internal organs of most parasitized hosts could be detected although some male rock crabs had atrophied gonads, suggesting parasitic castration by Nectonema. In the area of highest parasite incidence 48% of the rock crabs and 11.6% of the hermit crabs sampled were parasitized with Nectonema. The highly parasitized crabs were found at the head of the Bay of Fundy, which has higher summer bottom water temperatures and lower salinity than the outer Bay. The genus Nectonema requires taxonomic work.

IS THERE MORE TO ULVA THAN LACTUCA?

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The ubiquitous distribution and great abundance of the alga, Ulva on both the open coast and in shallow estuaries of New England makes Ulva a prime candidate for study. Yet, its well-documented morphological variation complicates any systematic approach. The recognition of only one species, U. lactuca, north of the Carolinas has served to compound the problems associated with identification. A seasonal field study in western Long Island Sound coupled with laboratory experiments documents the existence of 3 morphologically distinct forms of Ulva which correlate to the descriptions of Bliding. These include: U. lactuca L., U. rigida C. Ag., and U. rotundata Bliding. A possible fourth form, U. curvata (Kutzing) DeToni, has been found in low and fluctuating saline environments. Monthly samples were taken in an attempt to elucidate the seasonality of the forms. Cross-sectional and surface cell measurements, as well as cell arrangement, proved important for identification. Culture studies and hybridization studies are currently underway with preliminary results substantiating the distinction of the 3 species at all times during the year given some intra-species variation.

THE EFFECTS OF ICE ON ESTUARINE FUCOIDS IN NEW ENGLAND

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The effects of ice on intertidal macrophyte populations within the Great Bay Estuary System of New Hampshire-Maine, U.S.A. were studied during the winter of 1980-1981. Considerable biomass of intertidal fucoid algae was rafted in ice (i.e. $x = 1.04 \text{ kg dry weight/m}^2$). Localized ice-scouring occurred within the upper intertidal zone. Ascophyllum nodosum (L.) Le Jolis, the dominant fucoid, was extensively pruned as a result of ice-raft formation. The pruning action, although extreme during January-February, 1981, probably occurs each winter and contributes to the characteristic bushy habit of attached inner estuarine plants. Ice may also serve as a vector in producing the marsh ecad scorpioides:(Hornemann) Hauck. Most of the fragments of Ascophyllum removed from ice blocks were between 1 and 30 cm in length, weighed less than 20 g, had fewer than 5 branches, and corresponded to a loss of 1-3 years of growth. An estimated 136 metric tons (dry weight) of A. nodosum, or approximately one-half of the plant's winter standing crop, were removed by ice-rafting within the inner reaches of the Great Bay Estuary System. Similarly, large portions of Spartina alterniflora peat may be removed and transported to other sites by the ice action, establishing new populations.

A RAPID METHOD FOR ESTIMATING SUSPENDED SOLIDS LOADS

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An in situ nephelometric procedure for monitoring the suspended solids load resulting from construction activities in Great South Bay, New York was utilized in response to Environmental Protection Agency monitoring requirements.

The method proved simple, reliable, and rapid enough to allow for real-time control of construction activities.

DYNAMICS OF ADVECTIVE-DIFFUSIVE EFFECTS IN SEDIMENTS FOR TIME DEPENDENT FLUX INPUTS

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A general formulation for the effects of a time dependent flux input to a sediment system consisting of advective (sedimentation) and diffusive (bioturbation) properties has been developed. The formulation includes porosity variations within the sediment column, radioactive or other first order decay, and non-conservative exchanges at the sediment-water interface. The formulation is applicable to core data taken in estuarine, coastal, and limnological regions. Computer evaluation procedures have been developed and applied, for illustrative purposes, to the estimation of sedimentation rate, diffusion coefficient, mixed layer thickness and non-conservative exchange rate from published core concentration data with known input fluxes.

DISSOLVED ORGANIC CARBON IN ANOXIC PORE WATER FROM GREAT BAY, NEW HAMPSHIRE

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Gravity and box cores were obtained from a number of sites within the Great Bay Estuary to investigate the lateral, vertical, and seasonal variation, and the molecular size distribution of dissolved organic carbon (DOC) in these sediments. Strict anoxic conditions were maintained during all sample processing to avoid oxidation artifacts. DOC concentrations were observed to be considerably higher in pore water compared to overlying water values, indicating the presence of autochthonous production of DOC from sedimentary organic matter. No correlation exists between concentrations of DOC and dissolved sulphate in the pore water, indicating that DOC is being produced by bacterial processes other than sulphate reduction. Variations in pore water DOC concentrations from different sites in the estuary were found to correlate with sediment size variations. However, care must be taken in interpreting lateral differences since significant DOC concentration differences were observed in cores taken side by side. Significant seasonal effects on DOC concentrations were observed in this study, both in the top 12 cm of sediment and in deeper core sections. Molecular size distribution studies using ultrafiltration techniques indicate the presence of some lateral and depth variations in the molecular weight of the DOC, probably a result of bacterial activity and chemical condensation reactions.

THE LIMNOLOGY OF THE ANNAPOLIS RIVER AND ESTUARY

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Completion of the tidal dam at Annapolis Royal in 1960 transformed a vertically homogeneous type of estuary with 10 m tides into a highly stratified salt wedge estuary with a tidal range of 10.5 m. A distinct halocline and thermocline present throughout the headpond shows marked stratification within the first 3m. Reduced turbidity within these waters has resulted in a highly productive headpond relative to the waters of the Bay of Fundy. Plankton analysis indicates a diverse fauna consisting of both fresh and salt water species.

The causeway at Annapolis Royal is presently the site of construction for turbine installation. The environmental impact of tidal power development is of major concern to preliminary studies. Year round monitoring of some physical and biological parameters of the waters above and below the causeway is presently underway.

ELUCIDATION OF THERMOTEMPORAL ECOLOGY BY ELECTRONIC SHUTTLEBOX TECHNIQUES

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Using our Ichthyotron electronic shuttleboxes, we measured the diel activity patterns and preferred and avoided water temperatures of several Gulf of Maine species, including the winter flounder Pseudopleuronectes americanus, the sea raven, Hemitripterus americanus, and the lobster Homarus americanus. All of these species preferred temperatures (final thermal preferenda) in the 15-20 C range, corresponding to maximal summer temperatures in the Gulf of Maine. Upper avoidance temperatures were in the 25-30 C range, while lower avoidance temperatures were in the 5-10 C range. Activity patterns were nocturnal or crepuscular. Locomotor activity exhibited a local minimum in the region of the final thermal preferendum, an anomaly in the overall pattern of increasing activity with increasing temperature.

MARICULTURE METHODS FOR THE BAY SCALLOP ARGOPECTEN IRRADIANS,
USING SUSPENDED NET ENCLOSURES

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Small pyramidal enclosures and larger multi-tiered cylindrical mesh nets were used to grow hatchery-raised bay scallops from 5mm shell height to market size in Long Island Sound. Optimum size-specific densities were determined and appropriate handling frequencies are suggested. Results to date suggest the applicability of these methods for commercial mariculture of the bay scallop.

SALT MARSH UTILIZATION BY JUVENILE SMOOTH FLOUNDER
(LIOPSETTA PUTNAMI)

Brian Scully, Department of Biology, Acadia University

Previous study by workers at Acadia University has shown the near shore area of the southern bight of Minas Basin to be frequented by a variety of species of juvenile fish. As an extension of this work, one of the more commercially important species, the smooth flounder (Liopsetta putnami), is presently under study.

As a substantial part of the above mentioned area is bounded by productive salt marshes, it has been hypothesized that fish might utilize the area as a nursery feeding ground during their preadult development. Since late spring, sampling by beach seining has been undertaken twice weekly at several stations in a tidal creek.

Aspects of feeding ecology related to time of lunar month, hour of day, point in season, and development of fish will be examined. Biomass studies of the prey items will illuminate the relative importance of such items to the flounder and give some indication of the degree of selectivity, if any, exercised by the flounder in feeding. Length-weight relationships for the flounder as related to stage of development will be examined, as will the relative usefulness of otoliths and scales as implements of age determination.

The present study is being done in conjunction with others in an attempt at gathering baseline data prior to the implementation of the Fundy Tidal Power scheme.

EELGRASS, ZOSTERA MARINA, AND ITS SEDIMENT NITROGEN RESOURCES

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The size of the sediment interstitial ammonium pool in an Alaskan eelgrass meadow was compared to measurements of eelgrass standing stock using correlation analysis. These correlations were further analyzed during natural recolonization of an eelgrass meadow destroyed by ice damage and by eelgrass colonization of introduced foreign substrates. Plant colonization was accompanied by a decrease in interstitial ammonium concentrations.

GRASS IDENTIFICATION IN GUT CONTENT ANALYSIS

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In a study conducted at Watts Island in the Pattagansett Marsh System in Niantic, Connecticut, the gut contents of the salt marsh snail, *Melampus bidentatus*, and the amphipod, *Orchestia grillus*, were analyzed in order to determine food preferences and estimate roughly the relative abundance of the grass and algal components. The vast number of these two invertebrates in the marsh system could make their impact on the production of nutritionally enriched exportable material quite substantial. Thus in order to identify grass samples, often only microns in size when removed from the gut, it was necessary to compare them with photographs of known grass samples deliberately fragmented into minute pieces to expose unique microscopic epidermal features. Contrary to a previous study which indicated that the diet of *M. bidentatus* is composed of 75 percent algae and only 15 percent higher plants, preliminary results of this report indicate that *M. bidentatus* consumes about three times more grass than algae and *O. grillus* four and a half times more.

THE QUANTIFICATION OF ROCKY SHORE FUCOID SEAWEED BIOMASS AND COVER IN MAINE

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(No Abstract)

DISTURBANCE OF BENTHIC MACROFAUNA BY STORKS

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In coastal marine environments, storms are the most severe naturally-occurring physical disturbances and are presumed important in structuring soft-substrate communities. However, the effects of storms on benthic infauna generally have been inferred rather than documented; especially lacking are short-term temporal studies. To this end, we sampled two subtidal benthic sites and the water column (a third location) immediately before and after a storm in September 1979. There were no pre- vs. post-storm differences in the density of infauna at either benthic station. The number of species decreased at one of the stations following the storm. There were great post-storm increases in the numbers of species and individuals in the water column, probably caused by turbulent benthic boundary conditions. Because we saw no storm-associated change in benthic samples commensurate with change in the water column macrobenthos, we suggest that disturbance by storms permits wide post-larval dispersal of ostensibly obligate infauna.