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A three dimensional fully coupled ecological hydrodynamical model has been used to asses the role of the physical forcing of the seasonal cycle of phytoplankton in the Mediterranean Sea. Twelve state variables describe the nitrogen and phosphorus cycles coupled with fixed but compartment depedent N:P ratios. Two different size-fractionated functional groups represent small and large cells, and their evolution is governed by nutrient availability, light and temperature. In addition advection and turbulent diffusion act on all the biological variables reproducing the prevailing trophic regimes during stratification and mixing season and the concomitant response of the food web. The clorophyll surface seasonal cycle, as derived from the model results using a non-linear semi empirical formulation of the C:Chl ratio, compares favourably in a quantitative and qualitative way with the pigments concentration obtained from CZCS images calibrated for the Mediterranean Sea. An analysis of the buoyancy content, proportional to the integral of density anomaly contained above th depth z,, is used as a measure of stratification. The model simulations show that the buoyancy content calculated above the nutricline in the eastern and western subbasuns of the Mediterranean are locked in phase but the stratification is stronger in summer in the eastern part. This seasonal cycle induces a corresponding bloom-recyclin pattern for the autotrophs, which maxima are correlated the minimum of buoyancy. Even though large cells are dominant in wetern part and their concentration is almost three times the concentrations of the eastern basin, the integrated phytoplankton biomasses in the upper layer are not very dissimilar in the two subbasin. This result confirm recent hypotheses based on chlorophill data

OS21U-12 1135h

The Use of Chlorophyll Fluorescence Lifetime to Assess Phytoplankton Physiology within and around the Mississippi River Plume

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As an alternative to the14C technique, measurements of chlorophyll fluorescence lifetime provide a non-intrusive assessment of phytoplankton photochemical conversion and can be used to estimate parameters directly related to phytoplankton primary productivity. Phytoplankton carbon fixation estimated from 14C techniques are often difficult to make due to sample manipulation and artifacts common to the sampling within closed containers. Furthermore, the increased spatial and temporal coverage of chlorophyll fluorescence lifetime measurements, compared to classical incubation-based techniques used to estimate carbon fixation, provides a meaningful snapshot of photosynthetic efficiency within environments which are physically variable at relatively small spatial and temporal scales.

Chlorophyll fluorescence lifetime was used to assess phytoplankton photosynthetic efficiency within the horizontal and vertical mixing gradients associated with the Mississippi Rivers intrusion into the Gulf of Mexico. Numerous studies have addressed the seasonality and magnitude of primary production attributed to Mississippi River outflow, but few studies have examined the photosynthetic efficiency of phytoplankton along this estuarine continuum. Measurements of fluorescence lifetime, downwelling and surface irradiance, and phytoplankton absorption were used to estimate primary productivity within this environment. Productivity estimates derived from measurements of phase fluorometry were compared to previous estimates of primary productivity measured within the plume and within waters adjacent to river outflow.

OS22A HC: Hall III Tuesday 1330h

Research Experiences of Undergraduates in Ocean Sciences

Presiding: **R L Cuhel,** University of Wisconsin-Milwaukee**; C Aguilar,** University of Wisconsin-Milwaukee

OS22A-143 1330h INVITED POSTER

Dynamics of DOM Production by the Diatom *Thalassiosira oceanica*

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The fate of dissolved organic matter (DOM) is influenced by many factors in the open ocean environment, including biological (i.e. community structure), chemical (i.e. composition of inorganic nutrient pools), and physical (i.e. interannual and seasonal changes in physical forcing) variables. It is important to understand each of the mechanisms responsible for community shifts and changes in DOM cycling to gain a better predictive comprehension of an ecosystem and to recognize human-induced changes over a long-term time scale. In this study, the focus is the flux of material from POM to DOM and its composition (i.e. C:N:P ratio) based on growth parameters. This was completed through laboratory culture experiments with *Thalassiosira oceanica*, a species of diatom common to the Sargasso Sea. The triplicate cultures were initially nutrient-replete, and maintained at a constant temperate and light regime (12:12) for 8 days with low bacterial growth ($\mu_{bact} < \mu_{phyto}$). Measurements were taken at 3 points along the exponential and stationary phases of the growth curve. Significant differences were found between DON and DOP release. At a high growth rate (μ=0.81), almost all (99%) of NO_3 taken up was retained (little DON released), while a slight amount (15%) of DOP was taken up in addition to PO_4. At a low growth rate (μ=0.10), a large amount (74%) of NO_3 taken up was released as DON, while little (15% of PO_4 uptake) DOP was released. On day 1, the ratios of DON:DOP that accumulated in the medium compared to the phytoplankton biomass (PN:PP) were similar (5:1); however, by day 8, DON:DOP (19:1) was much greater than PN:PP (4:1). This suggests that the cells were passively leaking DOM during exponential growth, then, as their growth rate slowed, the cells actively released more DON to the medium than DOP. In conclusion, it has been demonstrated that the amount and composition of DOM released by *T. oceanica* varies with the growth rate and availability of dissolved nutrients. The compositional shifts in DOM under a lower light level, and DON release of natural assemblages of phytoplankton measured using ^{15}N tracer methods in field experiments will also be explored with further studies. These data provide a first step towards understanding the production and source of DOM, which is necessary before the mechanisms behind DOM cycling can be described.

OS22A-144 1330h INVITED POSTER

The Role of Epibiont Sponges and Their Microbial Symbionts in the Nutrient Limited *Rhizophora mangle* Stands

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In Twin Cays, Belize, diverse *Rhizophora mangle* subtidal epibiont communities, which are dominated by sponges, occur along the islands fringe, channels and lakes. Red mangroves in the fringe zone are severely nitrogen limited, which reduces their growth capability. Previous studies show that the presence of live sponges on *R. mangle* prop roots increases their biomass relative to spongeless roots. This relationship could be due to nitrogen-fixing processes mediated by symbiotic microbes within sponge tissue. I isolated bacterial genes from *Haliclona implexiformis*, one of the most abundant members of the sponge epibiont community. I used RFLP analyses to identify dominant members of the sponges bacterial community then analyzed 16S rRNA sequences to differentiate among bacterial species. I found four dominant species of bacteria in *H. implexiformis*. These numerically abundant bacteria might play important roles in mangrove community ecology. I am doing further work to characterize the trophic roles of these bacteria and predict ways in which they might affect nitrogen cycling.

OS22A-145 1330h INVITED POSTER

The Role of Fresh Groundwater Discharge in the Dispersion and Recirculation of Salt in Estuarine Sediment

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In estuarine environments significant groundwater systems exist that discharge fresh water into the near shore surroundings. This fresh groundwater can be mixed with salt water in the upper few decimeters of the sediment. As a result, net measured discharge rates at the sediment-water interface are equal to the volume discharge of fresh groundwater although the salinity of the escaping water is high. Seepage meters were used to measure discharge rates over about 50 l/day/m^2 near the shoreline of The Great South Bay, a wide, shallow lagoon with a tidal range of $\sim$0.21m situated at the surface of a coastal plain aquifer along the South Shore of Long Island, New York. These rates decreased to 15 l/day/m^2 at a distance of 100 m from shore. No consistent variation in discharge with tidal phase was found, but water collected at sampling locations freshened over time from 30 ppt to 23 ppt in twelve hours demonstrating a freshening of any salt penetrated sediment beneath the seepage meter and suggesting that the use of seepage meters turns off the mixing process. Piezometers recorded vertical hydraulic gradients (at ambient salinity, 28 ppt) between 0.08 and 0.02 in the upper meter of the sediment and the vertical hydraulic conductivity was measured by a falling head test to be between 1 and 20 m/day. Conductivity measurements showed the pore water salinity decreasing from ambient bay values at the surface to near fresh water values at a depth of 0.6m. The vertical downward dispersion coefficient for salt was estimated to be 0.02 m^2/day. Both wave induced transport and gravitational convection (salt fingering) into the sediments are considered possible mechanisms driving salt penetration that must be studied.

OS22A-146 1330h INVITED POSTER

Salt and Salmon: the Effects of Hard Water Ions on Fertilization

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Mine effluents contain a variety of ionic species that may be harmful to important organisms living in the discharge area. In this study the industrial effluent from the Red Dog Mine (near Kotzebue, AK) was modeled in the laboratory in order to determine the response of developing salmon to this specific effluent. Previous experiments demonstrated that an increase in total dissolved solids (TDS) in the simulated mine effluent caused a decrease in the fertilization rate of exposed salmon eggs. The current study attempted to determine which specific ionic species were responsible for this decrease in fertilization. Concentrations of K^+, Ca^{+2}, $SO_4^=$, and Mg^{+2} typical of their presence in a 2500 ppm mine simulation effluent were tested in a salmon egg fertilization experiment. Since previous

experiments demonstrated that NaCl at the same osmotic equivalent as the 2500 ppm solution has no effect on salmon fertilization, counter ions were selected to be Na^+ and Cl^-. Compounds utilized in this experiment were Na_2SO_4, $CaCl_2$, $MgCl_2$, and KCl. A set of 24-hour assays was preformed on both king and pink salmon provided by Douglas Island Pink and Chum, Inc. (DIPAC) Macaulary Hatchery in Juneau, AK. Treatments consisted of the molar equivalents of the chemical species in the 2500 ppm TDS concentration, four times that amount, and one-fourth that amount. A 2500ppm solution and process water from Salmon Creek (the water supply that feeds the hatchery) were run as controls. Assays illustrated that both $CaCl_2$ and Na_2SO_4, had the greatest detrimental effect on egg fertilization. This result suggests that Ca^{+2} and $SO_4^=$ are responsible for the main effect in the simulated mine effluent. But caution is advised due to the confounding effect of Na^+ and Cl^- ions at such high concentrations.

OS22A-147 1330h INVITED POSTER

The Relationship of Seabed Conditions and Suspended Sediment in the Water Column of the Chesapeake Bay ETM Region

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The Estuarine Turbidity Maximum (ETM) of the Upper Chesapeake Bay is an area in which details of the processes that trap and maintain sediment in suspension are not well known. The study contains information on the first of six cruises to the area. Sediment sampling and water column analyses were conducted in an attempt to better understand the complexities of the area. Identifying a preliminary pattern in bed responses was the primary goal of this component of the study. Methods used to analyze sediment included Eh, grain size, percent moisture , and ^{7}Be. Sediment properties were found to be generally correlated with the position of the ETM. Eh values in the upper bed became increasingly positive with distance along the channel to the north and the northernmost muddy channel stations were characterized by high water content and presence of ^{7}Be. Overall, the patterns of Eh, water content, grain size and ^{7}Be all suggest that the location of the northern bay ETM is associated with an area of recently deposited, and easily resuspended mud.

OS22A-148 1330h INVITED POSTER

Extraction of the Regional Bathymetry of the Pacific Plate Using Median Filtering: Implicatons for Geophysical Models

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The regional-residual separation of bathymetric data is important for constraining geophysical models. One of the primary techniques for achieving this separation is median filtering. In this study, we examine a novel technique for applying median filtering to bathymetry. After testing this method on synthetic data, we apply our analytical technique to the Pacific Plate. This yields regional and residual maps of the Plate, and allows the construction of a depth-age plot. Our preliminary results indicate a shallower regional bathymetry than the GDH1 model, especially at ages greater than 80 Ma.

OS22A-149 1330h INVITED POSTER

Flow Modeling Around an Autonomous Underwater Vehicle With Applications to Turbulence Measurements

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Linear sandbanks are common features off the eastern coast of continents. Validation of proposed mechanisms for the formation of these features requires spatial mapping of turbulence in the bottom boundary layer over the banks. We equipped the AutoSub, an autonomous underwater vehicle developed and operated by the Southampton Oceanography Centre (UK), with a single-point Acoustic Doppler Velocimeter (ADV), and a downward looking Acoustic Doppler Current Profiler (ADCP), to measure near-bed turbulence and shear over Broken Bank in the North Sea. Spectra of velocity estimated from the ADV data are distorted due to the presence of the body, and the goal of this project is to find a way to recover information about the tidally-forced turbulence in the bottom boundary layer from these data. To investigate this possibility, we modeled the flow field around the AutoSub using a computational fluid dynamics (CFD) code (Fluent 5.5) employing a Reynolds stress closure. The results of the computation show that whereas the dissipation and shear stresses at the ADV are larger and smaller by an order of magnitude than their respective upstream values, the normal stresses (and hence the turbulent kinetic energy) are not perturbed significantly. An analysis of the terms in the turbulent kinetic energy (TKE) balance shows that roughly 60% of the enhanced dissipation is balanced locally by shear production, with the remainder being attributable to advection and transport. Although the net production of TKE at the ADV is small, it is concentrated at relatively small scales, and hence affects the velocity spectrum principally at high wave numbers. As a consequence, we expect the low wave number part of the spectrum will more closely reflect the ambient geophysical turbulence. This expectation is supported by the reasonable agreement between dissipation rates estimated from this range of the spectrum, and those calculated from the ADCP shear measurements close to the bed assuming an approximate balance there between production and dissipation. Our results also suggest that the perturbation of the large-scale turbulence by the vehicle can be addressed via rapid distortion theory.

OS22A-150 1330h INVITED POSTER

Bacterial Growth Using Dissolved Organic Carbon From Nutrient-Replete and Nutrient-Limited Phytoplankton

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Marine bacteria rely on the dissolved organic material (DOM) produced by phytoplankton as their source of carbon. However, little is known about how the source and quality of DOM affects bacterial growth rates, growth efficiencies, and community structure. Recent research has shown that DOM chemical composition varies greatly when produced by phytoplankton growing under nutrient-limited or replete conditions. In this study, I examined how growth on DOM collected from iron- and nitrogen-limited diatom cultures affects the growth of a cultured marine bacterium and natural bacterial communities from the mid-Atlantic bight. Fluorescence in-situ hybridization (FISH) was also used in the natural community experiments to examine changes in the abundance of 4 major subclasses of marine bacteria (alpha, gamma and beta proteobacteria and Cytophaga/Flavobacteria). The cultured gamma proteobacterium *V. harveyi* was grown in seawater medium using extracellular polymeric substances (EPS) from phytoplankton that were Fe-limited, Fe-replete, N-limited, or N-replete as sole carbon sources. While there were no changes in final bacterial abundance in any of the experiments, growth rates were substantially higher for the bacteria utilizing Fe-limited EPS and N-replete EPS. In addition, 67% more carbon was present per cell in the bacteria grown on the Fe-limited EPS than in the Fe-replete EPS, suggesting large differences in cell size in these two treatments. In the similar experiments using coastal seawater, direct counts also indicated no overall change in final bacterial abundance, but preliminary FISH results indicate a substantial shift in bacterial community composition. The initial community was dominated by gamma and beta proteobacteria (71% and 16% of total bacterial cell counts, respectively). In both seawater media supplemented with EPS from nutrient-replete phytoplankton, bacterial community composition changed little over a 48-hour incubation. However, in media supplemented with Fe- and N-limited EPS, there were major increases in the relative abundance of alpha (52% and 28%) and beta (67% and 41%) proteobacteria, whereas gamma proteobacteria declined substantially (to 45%). These results suggest that changes in DOM composition due to variations in the nutrient status of phytoplankton can have a major effect on growth and taxonomic composition of bacterial communities, and therefore on the structure and functioning of the microbial food web.

OS22A-151 1330h INVITED POSTER

Constructing a Record of Red Sea Overflow During the Late Holocene

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This project focused on understanding the role of the tropics in the millennial-scale variations in Holocene climate. Recent paleoclimate data has identified 1000-2000 year oscillations in high-latitude glaciers and oceans, culminating in the Medieval Warm Period (ca. 900-1400 years BP)-Little Ice Age (150-700 years BP) climate cycle of the last 1000 years. I examined the past linkages between high- and low-latitude climate by constructing a late Holocene record of Red Sea Overflow Water (RSOW) into the Gulf of Aden. RSOW has a characteristic temperature and salinity signature compared to the surrounding waters into which it flows and should be sensitive to climactic changes in the region of formation, near the Sinai Peninsula. RSOW forms in the northern Red Sea as a result of winter cooling of highly saline surface waters. These waters ventilate the abyssal Red Sea (residence time ∼20 years) and are exported into the Gulf of Aden at a depth of ∼500-800 m.

The 53 cm core 178P-BC-12 was taken (May, 2001) from a reoccupation of the RC09-166 site. A previously published stable isotopic stratigraphy at this site suggest 10-15cm/ kyr sedimentation rates (Locke and Thunell, 1988, Palaeogeo. Palaeoclim. Palaeoecol. 64, 164-187). Approximately 30 specimens of the benthic foraminiferan *Uvigerina macrocarinata* were picked from each 1 cm sample level of the core. These were gently crushed, mixed, and split for separate $d^{18}O$ analyses and Mg/Ca analyses. The Mg/Ca samples were cleaned to remove organic and authigenic contaminants. The isotopic measurements were conducted on a mass spectrometer and Mg/ Ca measurements were conducted in duplicate pairs using an ion-coupled plasma atomic emission spectrometer (ICP-AES).

The resulting Mg/Ca ratio data were found to have large amplitude variations corresponding to bottom water changes of ∼4-5°C. The 53-cm core represents approximately the last 3,000 years of sediment deposition and the Mg/Ca data indicate two well-defined oscillations that may be compared to the late Holocene millennial-scale variations detected at higher latitudes. Interestingly, the implied temperature variations not observed in the benthic $d^{18}O$ record, which suggests that the temperature and salinity effects on calcite $d^{18}O$ may compensate each other. What was surprising about these results was that the late Holocene bottom water temperature variations were so large, since the estimated variations in high latitude temperature are only 1-2°C for the late Holocene.

OS22A-152 1330h INVITED POSTER

The Effects of Small-Scale Shear on *Pfiesteria piscicida*

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Toxic blooms of the dinoflagellate, *Pfiesteria piscicida*, have been implicated in fish kills and adverse human health effects in several estuaries along the U.S. East Coast in recent years. Previous work on other toxic dinoflagellates and indirect evidence from field observations led to the hypothesis that turbulent shear is one of the factors controlling the occurrence of *P. piscicida* blooms. In the present experiments, *P. piscicida* was exposed to varying levels of shear comparable to those found in its natural environment. The shear rates

tested, produced by Couette devices, were 0, 1, 3, and 10 s^{-1}. *P. piscicida* and its prey, *Storeatula major*, were put in Couette devices at known concentrations and, at 24 hour intervals over 4 days, samples were withdrawn to measure the effect of shear on *P. piscicidas* growth and ability to graze on *S. major*. It was found that below 1 s^{-1}, shear did not affect *Pfiesteria* growth significantly. However, at 3 and 10 s^{-1}, shear significantly affected *Pfiesteria* growth. In a supplemental experiment testing the feeding rates of a starved culture of *Pfiesteria* after an hour of exposure to food and shear, the proportion of *Pfiesteria* feeding cells was inversely dependent on the level of shear.

OS22A-153 1330h INVITED POSTER

Analysis of RNA:DNA Ratio as an Indicator of Nutritional Fitness of Moon Jellyfish

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Jellyfish are voracious predators in marine and estuarine ecosystems, however *in situ* growth patterns of jellyfish are difficult to assess because of the absence of direct size to age relationships in jellyfish. The moon jelly, *Aurelia aurita* (Scyphozoa), was used to assess whether an indication of growth was apparent in RNA:DNA ratios, and whether RNA:DNA ratios in jellyfish tissue varied with recent feeding. We sampled jellyfish across a range of producing regimes to determine RNA:DNA ratios and to measure gut contents. The general population of *A. aurita* had RNA:DNA ratios similar to other marine organisms such as copepods (values ranging from less than one to four). Medusae collected offshore in lower producing waters had higher RNA:DNA ratios ($\sim$1.53 for offshore and $\sim$1.44 for nearshore). This may be the result of offshore individuals feeding on microzooplankters that are found in abundance in offshore waters. This would lead us to believe that predation on microzooplankton by jellyfish is more significant than before realized.

OS22A-154 1330h INVITED POSTER

Direct Counts of Microorganisms in Yellowstone Water Samples

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Yellowstone Lake is located in Yellowstone National Park, Wyoming. 630,000 years ago a large volcanic eruption occurred which created a large caldera. The lake is located in this caldera and fuels the hydrothermal vents found in the northern part of the lake as well as other famous geological features found elsewhere. Associated with hydrothermal vents are unique communities of bacteria dependent on this ever-changing ecosystem for nutrients. Direct counts, using epifluorescence microscopy, of vertical water profiles sampled at Mary Bay canyon, West Thumb Canyon, West Thumb and Stevenson Island are done to observe the population density of bacteria in these areas. Water from Mary Bay vents and the Mary Bay canyon water profile showed consistency higher numbers than West Thumb Canyon, West Thumb and Stevenson Island vents and profiles. Mary Bay Canyon is not affected by the mixing of layers in the lake, while other areas are mixed regularly. The Mary Bay canyon ecosystem is rich with nutrients fed by the vents enabling bacteria in the canyon to have higher population densities and thrive.

OS22A-155 1330h INVITED POSTER

Role of Symbiotic Algae in Affording Protection Against UV Damage in the Anemone *Anthopleura elegantissima*

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The temperate sea anemone *Anthopleura elegantissima* contains two different algae: zooxanthellae (ZX), yellow-brown dinoflagellates belonging to the genus *Symbiodinium*, and zoochlorellae (ZC), which are green chlorophytes. These two symbionts are ecologically separated in the environment on the basis of temperature and light, with zooxanthellae encountered in anemones under higher light and temperature conditions than zoochlorellae. To determine if UV-B radiation affects the distribution of the two symbionts in *A. elegantissima*, we took the four different symbiont possibilities (ZX only, ZC only, Aposymbiotic (= algae-free), and Mixed (= ZX and ZC)) and subjected anemones of each type to plus or minus UV and PAR light for up to 26 days. UV exposure caused a decrease in weight of all anemones, but the effect was especially pronounced in zooxanthellate (49% loss) and aposymbiotic (46% loss) anemones. Both zooxanthellate and zoochlorellate anemones contained a UV absorbing compound which peaked at around 330 nm. Aposymbiotic anemones were found to have little to no UV-B absorbing compounds. Decreases in the concentrations of UV-B absorbing compounds were seen over time in the presence of UV. UV radiation did not have significant effects on carotenoids or chlorophyll content of algae isolated from anemones. Zooxanthellae had nearly twice the carotenoids that zoochlorellae had per cell. Results show that zoochlorellae may provide a distinct advantage over zooxanthellae in protecting their host from UV damage, but this protection may depend on the concentration of algae and not directly on the amount of UV absorbing compounds or carotenoid.

OS22A-156 1330h INVITED POSTER

Environmental Magnetic Studies of Sediment Cores From Lake Bosumtwi, Ghana

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Paleomagnetic studies are concerned with temporal variation in the inclination and declination of the Earth's magnetic field. Rock magnetic studies are used to determine temporal variations in magnetic mineral concentration, magnetic mineralogy and magnetic grain size. These temporal variations are used to construct age models and are also extremely useful proxy records of paleoenvironmental changes. Together paleomagnetic and rock magnetic studies comprise the field of environmental magnetism.

Paleomagnetic studies of piston cores obtained from Lake Bosumtwi, Ghana during the summer of 2000 indicate that high quality records of paleosecular variation (PSV) can be obtained that span the last $\sim$23,000 years BP. The directional data are stable and single component. The inclination data vary around expected geocentric axial dipole values for the site latitude, indicating accurate recording of the Earth's field. Two depth intervals of relatively noisy PSV data were observed that correspond to lithologic units with abundant "turbidite-like" layers. Despite the noisy intervals, good correlation exists between the inclination records of Lake Bosumtwi and Lake Barombi Mbo in Cameroon. The quality of this correlation indicates that PSV studies will be capable of providing high-resolution regional correlations between paleoclimate records from sites in West Africa. The results of rock magnetic studies indicate that the intervals of noisy PSV data have undergone partial reductive diagenesis characterized by low magnetic concentrations, low hematite concentrations, and larger magnetic grain sizes. These lithologic units are interpreted as being deposited in deep lake phases that produce more anoxic conditions in the sediment column and correspond to wetter climatic conditions. The "turbidite-like" layers may be produced by major rainfall events during these wet intervals.

Stratigraphies of two rock magnetic parameters, low-field susceptibility, and the hematite concentration parameter (HIRM), show potential as paleoclimate and paleolake level indicators. The HIRM parameter appears to be a "clipped" proxy record that has low values during deep lake phases due to reductive diagenesis. On the other hand, the low field susceptibility record does not appear to be similarly clipped and may be the most useful magnetic climate proxy for Bosumtwi sediments. Higher values of susceptibility correspond to lower lake levels, whereas low values correspond to higher lake levels.

OS22A-157 1330h INVITED POSTER

10 Years of Green Bay Transects: The NSF-OCE Research Experience for Undergraduates (REU) Cruises

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Midsummer chlorophyll *a* concentrations in lower Green Bay have dropped from over 50μg/L in the early 1990's to less than 5μg/L in 2000. This has been accompanied by a change in midsummer dominant phytoplankton species , particularly noticeable in a strong reduction of diatoms and greater upbay persistence of buoyancy-regulating *Microcystis* spp. Likewide, total phosphorus has decreased significantly. Benthic invertebrates have shifted from abundant, nearly monospecific populations of bloodworms (Chironomideae)to much more diverse, lower-deposition infauna including open lake *Diporeia*-like amphipods. Taken together these observations indicate that both autochthonous productivity and allochthonous import of biomass into the Green Bay ecosystem have dramatically declined. The presumed causative agent is zebra mussels, whose feeding activity can both reduce phytoplankton biomass and alter its species composition.

The entire suite of activites including cruise preparation, on-board sampling and analysis, and post-cruise workup was undertaken by NSF-OCE undergraduate REU students as a component of summer internship. When adequately supervised by an REU Site team, such programs can provide scientifically valuable as well as educational experience. Voluntary participation in the "long cruise" (6 days port-to-port) is highly correlated with later indices of REU "success".

URL: http://www.uwm.edu/Dept/GLWI/reu.html

OS22A-158 1330h INVITED POSTER

Interdisciplinary Team Participation at the UW-Milwaukee Center for Great Lakes Studies Research Experience for Undergraduates Site

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The 1996-2001 REU sessions at the Center for Great Lakes Studies included a significant effort at interdisciplinary team applications involving up to 5 REU students per year. The students participated in federally-sponsored Yellowstone Lake Hydrothermal Vents studies (National Undersea Research Program; NSF-Environmental Geochemistry and Biogeochemistry, Life in Extreme Environments) in addition to standard components of the core program.

During the third week our annual Lake Michigan survey cruise on the R/V LAURENTIAN was accomplished. Five of the students participated in all phases of sampling design, equipment set-up, ship loading, station occupation, and data work-up. Altogether 30 stations covering most of Lake Michigan and Green Bay (see "10 Years of Green Bay Transects..." in this session) were visited.

The Yellowstone groups included chemistry/geochemistry, hard rock geology, biology, and environmental policy majors. They spent four weeks at the Park working with small boat and ROV submersible technology to investigate hydrothermal activity in Yellowstone Lake. On-site mentors included the P.I.s Cuhel and Aguilar, biogeochemist J. Val Klump, and microbiologist C.C. "Tony" Remsen (all UWM-CGLS); Marquette University microbiologist and Co-PI Jim Maki; sub contractor Dave Lovalvo; USGS trace metal chemists and stable isotope geochemists, a guest geologist from a collaborating University, and a host of US Park Service Ranger-Scientists. Each student had an individual project and also contributed to each and every phase of submersible and traditional sampling. A strong sense of membership was evident. Students had an opportunity to develop their own project and also have a dynamic interaction with all or some components of the overall project. Students could choose to spend as much time as needed to interact with scientists as well as with other students in multi-faceted experiments. The teamwork displayed by the group was outstanding, leading to a synoptic, highly diversified research product. Each of the final posters included some level of significant reference to several of the other students' projects, and in fact two of the geochemists gave a joint presentation. Most importantly, several new insights were obtained through the innovative individual projects of the students. A

synopsis in text, data, and pictures documents their breadth.

URL: http://www.uwm.edu/Dept/GLWI/reu.html

OS22A-159 1330h POSTER

The Summer Intern Program at the Virginia Institute of Marine Science, The College of William and Mary

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With funding from the National Science Foundation through the REU Program, The Virginia Institute of Marine Science has offered summer research experiences to talented undergraduates since 1989. Internships are available in many areas of coastal marine science, including biological, geological, chemical, physical, environmental science, fisheries and management emphases. The basis of the summer program is an independent research experience for each student. Working with faculty mentors, and often within the context of a research team, interns develop and execute individual projects. Depending on the project chosen the summer can involve lots of 'hands-on' experience in the field or laboratory, or both. Interns are expected to work with their mentors to develop a project idea in the form of a brief research prospectus, conduct their research, and then present their results in a final symposium that is open to the VIMS community. Interns also prepare a paper summarizing their research results for the program archives. Group activities during the summer include a series of field trips to cover the land-margin interface from tidal freshwater to the open coast, and weekly seminars on topics ranging from science to career planning.

URL: http://www.vims.edu/sms/intern

OS22A-160 1330h POSTER

Vertical Migration of Zooplankton in a Semi-tropical, Polymictic Lake

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Diel vertical migration has long been recorded in zooplankton populations. This phenomenon can be explained by several theories, including the metabolic advantage theory and the predator avoidance theory. Our study area, Lake Somerville, Texas, is a shallow, polymictic lake that year round shows little variance in temperature through the water column. At the time of our sampling, March, 2001, there was little variation in dissolved oxygen as well. These physical conditions negated any metabolic advantages gained by vertically migrating zooplankton, and made Lake Somerville an ideal system for investigation of vertical migration as a function of predator avoidance. We hypothesized that any observed migration patterns would occur in a pattern opposite to that of the main zooplanktivorous fish. To test this hypothesis, we documented water quality parameters, zooplankton abundance, and fish activity over a 24-hour period where our sampling frequency was every two hours. It appeared that larger zooplankton groups (*Bosmina* sp., *Daphnia* sp., adult copepods, and copepod nauplii) migrated in a reverse pattern, i.e., nocturnal descent to the benthos. This resulted in maximum abundance in surface water during daylight hours when the predominant zooplanktivorous fish, *Dorosoma cepedianum*, the gizzard shad, was also most abundant. The dominant rotifer, *Brachionus* sp., showed the expected vertical migration pattern, i.e., nocturnal ascent to the surface, which was opposite to that of the gizzard shad. The patterns of several less abundant rotifer species were harder to determine, but seemed to indicate a genera-specific preference for varied depths. Explanations for the observed phenomena and future research considerations are discussed. This work was supported, in part, by the NSF Research and Education for Undergraduates Program at Texas A&M University.

OS22A-161 1330h POSTER

Predation by the Chaetognath *Sagitta enflata* in Southern Kaneohe Bay: Diel Feeding Behavior and Prey Selectivity in the Aftermath of Sewage Eutrophication

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Predatory behavior of the chaetognath, *Sagitta enflata*, was well documented by mid-1970s studies in Kaneohe Bay, Oahu, Hawaii during the peak of sewage eutrophication. The system has recovered in the two decades following sewage diversion and now supports a 5-fold lower concentration of zooplankton prey. The present study was conducted to test the hypotheses that present food levels are substantially below those supporting maximum growth of *S. enflata* and have led to significant changes in its diel feeding behavior and prey selectivities. Diel sampling was conducted during two 24-h periods in summer 2001 using nets of 64- (microzooplankton) and 335-μm mesh (mesozooplankton). Sampling frequency was every 2-3 h, with half-hour samples between 1800 and 2100 h, the expected peak time of feeding activity from previous studies. Gut content ratios and selectivities were determined by microscopical examination. We found little change in the diel feeding pattern of *S. enflata*, with gut content maxima around sunset and in the early (pre-dawn) morning. Prey clearance rates, from gut contents and digestion times, were also comparable to those determined previously. Hence, daily ingestion rates had declined from 8.8 to 1.6 prey chaet^{-1} d^{-1}, approximately in proportion to the decrease in prey abundance. Post-naupliar copepods continued to be the dominant prey item of *S. enflata*. However, *Oikopleura* spp., originally a dominant component of the plankton community and preferred prey of *S. enflata*, was not present in Kaneohe Bay at the time of our sampling. Although *S. enflata* exhibited a preference for the copepod *Oithona simplex* among copepod species, electivity of *S. enflata* has shifted to a more uniform impact among dominant groups: post-naupliar copepods, chaetognaths, and shrimp larvae. We can conclude from this study that *S. enflata* has changed its feeding behavior only modestly in response to major changes in prey availability.

OS22A-162 1330h POSTER

Dominance of *Microcystis* sp. and *Oscillatoria* sp. in Lake Somerville, Texas: Does Grazing Keep Them Non-Toxic?

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Lake Somerville is a man-made lake designed to be a reservoir for downstream agriculture, and a source of drinking water for the town of Somerville, TX. High concentrations of cyanobacteria have been found in the lake. Considering the potential for adverse health effects for humans and animals, a study was conducted that focused on the autoecology and potential toxicity of the cyanobacteria present.

Monthly sampling excursions of six sites were made from January 1999, through August 2001. Data was collected from all sites, but only data from site 1 has been extensively analyzed. Inverted light microscopy was used for enumeration of the phytoplankton. High performance liquid chromatography (HPLC) was used to analyze cyanotoxin concentrations in the samples. Biovolume data indicated that two potentially toxic cyanobacteria populations, *Microcystis* sp. and *Oscillatoria* sp., dominated the community at different times during the year, however, HPLC analyses indicated that no microcystins were present.

Conditions in Lake Somerville were conducive to cyanobacteria, i.e., surface water temperature, total phosphorous, and pH were high, and the lake was experiencing a relatively dry year. Because of the location (semi-tropical) of Lake Somerville, seasonal fluctuations in the lake are moderate, and the phytoplankton community might remain at a near steady-state condition. Studies have shown that microcystin production is not as great while cyanobacteria are in early log-growth phase. Because the lake might have been at near steady-state, top-down control through grazing, as indicated by lower chlorophyll *a* to phaeophytin *a* ratios, might have prevented cyanobacterial accumulation of biomass, thereby preventing depletion of nutrients. In turn, this might have prevented cyanobacteria from entering late log-growth phase when production of microcystins would have been greater. Another possibility is that the *Microcystis* sp. and *Oscillatoria* sp. present in Lake Somerville were of a non-toxic variety.

This work was supported, in part, by the NSF Research and Education for Undergraduates Program at Texas A&M University.

OS22A-163 1330h POSTER

Ebb and Flood Dynamics at Humboldt Bay, California

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Humboldt Bay comprises two distinct bays (Arcata Bay to the north, South Bay to the south) which are connected by a long thalweg. Overall, Humboldt Bay is relatively well-mixed vertically, although horizontal gradients in water properties are often observed from the ocean to deep within the bay.

Several drifters, drogued at 1.5 m below the surface, were released from sites north and south of the Humboldt Bay entrance over the course of an ebb tide. Within one hour of low tide, flow from Arcata Bay was faster than South Bay by a factor of 2-3, with peak flow speeds reaching 75 cm/s. In addition, drifters from Arcata Bay were transported across a wide area within the entrance, while those released from South Bay were held close to the south jetty. This pattern continued until roughly one hour before low tide, when flows from both bays became comparable. We suggest the most likely cause for this evolution is the large difference in tidal prisms for Arcata and South Bay and the location of the main (dredged) navigational channel, which runs alongside the south jetty near the bay entrance.

We also attempted to determine whether or not a portion of an ebb plume returned to the bay on the subsequent flood. To identify and differentiate plume and ocean waters, several characteristics were measured offshore, at the bay mouth, and at two sites within the bay. These characteristics included temperature, salinity, turbidity (as extinction coefficient), total suspended matter, chlorophyll, ammonium, dissolved oxygen, and nitrate concentrations. Most measurements were taken within 1 m of the ocean surface; some additional observations were made at 4 m and just above the bottom. The most promising "tracers" of bay effluent proved to be turbidity, chlorophyll, and ammonium concentrations. At the bay entrance, the tracers suggested detectable levels of plume water returning to the bay during the first three hours of the flood.

OS22A-164 1330h POSTER

Ciguatera and Water Quality on the Big Island of Hawaii: Is There a Connection?

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Six sites around the Big Island of Hawaii are being sampled on a biweekly, ongoing basis to study the distribution of *Gambierdiscus* spp. and other potentially toxic epiphytic dinoflagellates (e.g., *Prorocentrum* and *Ostreopsis* spp.). Prior studies have demonstrated that ciguatera (a form of seafood poisoning caused by toxins produced by some dinoflagellates) is more prominent on the leeward (west) coast than the windward (east) coast of the Big Island, possibly reflecting a greater concentration of ciguateric dinoflagellates in west Hawaii. Incoming results, however, indicate that *Gambierdiscus* and other potentially toxic dinoflagellates are present and often abundant in east Hawaii, demonstrating that ciguatera outbreaks do not simply reflect dinoflagellate distributions. Fish tissue samples are currently being

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tested for the presence of ciguatoxins to compare the frequency of occurrence of ciguatoxin in fish caught in west versus east Hawaii to determine if leeward fish are differentially exposed to ciguatoxins versus windward fish. Dinoflagellate distribution data will be compared with fish toxicity and dissolved nutrient data to examine the potential role that water quality may play in ciguatera outbreaks on the Big Island.

OS22A-165 1330h POSTER

A Treatice on the Abundance and Turnover of Transparent Exopolymer Particles (TEP) in Puget Sound, Washington

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The objectives of this study were to determine the relationship between phytoplankton productivity and TEP production in the Main Basin and Hood Canal of Puget Sound. Chlorophyll and TEP samples were taken at three depths, including the chlorophyll maximum, and four day long incubations were constructed with seawater from the chlorophyll maximum at one Hood Canal and one Main Basin station. TEP concentrations were determined spectrophotometrically using an alcian blue stain. Phytoplankton productivity was measured using 14C incubations to quantify TEP production with respect to phytoplankton productivity. A positive correlation between TEP concentration and productivity was observed in Main Basin incubations where the dominant plankton were diatoms. However, in Hood Canal incubations no correlation between TEP and phytoplankton productivity was observed. TEP concentrations measured in the Main Basin were significantly lower then expected ranging from 21.8 g xanthan equivalents per liter to 76.4 g xanthan equivalents per liter. Single cells of Phaeocystis were dominant in Hood Canal and are known to produce larger amounts of carbohydrates. Higher TEP concentrations were therefore measured in Hood Canal incubations, up to 1579 g xanthan equivalents per liter. Relating TEP production and abundance to productivity, chlorophyll a, and phytoplankton abundances will increase our understanding of the timing and mechanisms involved in TEP interactions, aggregation, and sedimentation.

URL: http://students.washington.edu/jsatterb

OS22A-166 1330h POSTER

Phototactic Behavior of Marine and Freshwater Copepods as Influenced by Habitat and Light Quality

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Marine and freshwater zooplankton exhibit similar phototactic behaviors despite fundamental physical differences between their respective habitats. These behaviors stem from a common physiology as well as analogous challenges regarding predator avoidance and foraging. This study examines the phototactic behavior of the freshwater copepod *Diaptomus* and the marine copepod *Acartia* across a range of specific light wavelengths of equal intensity. Organisms were placed into small vessels, through which a light beam of specific wavelength was projected. Using a high-resolution video system, we then observed and recorded the position and activity of the copepods in response to each light treatment. Data were analyzed to compare the interspecific behavioral responses to different wavelengths, and to identify overarching intraspecific variation. Results show variations in phototaxis within each species in response to different light treatments, and marked differences in activity levels between *Diaptomus* and *Acartia*. In addition, our results suggest that species specific responses may also be influenced by the light regime that characterize its habitat.

OS22A-167 1330h POSTER

Investigations Into the Phototactic Behaviors of Marine and Freshwater Mysids.

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The phototactic behaviors of zooplankton can have far-reaching effects with respect to the trophic dynamics of both freshwater and marine aquatic systems. The light regimes in freshwater and marine systems also differ due to differences in the physical characteristics of each locale, potentially influencing the way organisms react to stimuli. The purpose of this project was to investigate the effect that varying light regimes have on the behavioral responses of mysid shrimp. For our study, we observed *Mysidopsis bahia*, a marine mysid found in most coral reefs in the Caribbean Sea, and *Mysis relicta*, a freshwater mysid characteristic of many lakes in the northern United States and southern Canada. Specimens were placed in an observation vessel and exposed to a beam of light of a specific wavelength and intensity. Behavioral responses of the mysids were monitored using a high-resolution camera and a high-resolution monitor, and were recorded on a VCR for subsequent analysis. There were distinct differences in type of response to the various wavelengths tested within each species, and those responses differed when compared to the other species. Our results suggest that the natural light regime in each species' respective habitats may influence phototactic behavioral patterns.

OS22A-168 1330h POSTER

Status and Biogeochemical Impact of the Aimakapa Hawaiian Fishpond

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Aimakapa fishponds is of several large coastal ponds in the Koloko-Honokohau National Historical Park on the west side, or "Kona", coast of the island of Hawaii. This pond is part of an extensive anchialine system of ponds, usually having no direct connection to coastal waters, but showing measurable salinity and tidal rhythms. Aimakapa fishpond has served as a useful fish-producing system up until the 1960s but has fallen into disuse, and may be becoming increasingly eutrophic. Aimakapa currently has no opening ('auwau kai) to the sea, and has become heavily silted and infilled. The Aimakapa system, however, does provide a relatively-protected habitat for many endangered waterbirds, such as the Hawaiian stilt and the Hawaiian coot. In cooperation with the National Park Service we have begun an examination of the biogeochemistry of the waters and sediments of this ecosystem, to understand the current- and projected-impacts this system may have on local coastal coral reef ecosystems, should it be restored to full use. We are also assessing the overall inorganic nutrient levels, their fluxes, and their sources, in order to assess the relative impact of planned and existing industrial developments near the Park, as well as to understand the biogeochemical function of this ancient ecosystem. The sediments within Aimakapa are anoxic and may harbor harmful anaerobic microorganisms such as Clostridium botulinum. We have examined Aimakapa in a series of inland-shore (mauka-to-makai) sampling transects for pond water and sediment. Our preliminary data indicates the system has lower salinity (approximately 11 ppt.) on the bottom of the ponds than that of the surface waters (approximately 13 ppt.), consistent with the anchialine flow component. We will present our cross-pond interstitial water inorganic nutrient profiles and estimates both of diffusive and advective fluxes of inorganic nutrients.

OS22A-169 1330h POSTER

Optical estimation of Phytoplankton and Sediment Transport in Morro Bay Estuary

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Morro Bay National Estuary, California has experienced an increase in sediment deposition resulting from land use changes in the surrounding watershed. An increase in suspended particles in the water and the resultant loss of the estuarys aerial extent has had a detrimental effect on the survival of benthic filter feeders and other invertebrates. Two possible explanations for sedimentation events are increased erosion from fresh water sources into the bay, and the transport of sediment from adjacent coastal waters. To assess sediment loading and primary production over an extended period of time under a variety of environmental conditions, moored instruments (HydroScat-6, CTD) took physical and optical measurements at forty-five minute intervals between October 2000 and May 2001. Discrete measurements were taken during optical sampling intervals and correlated with instrument data. Through observation and statistical validation between the differences of incoming and outgoing tidal components, this data set provides evidence for Morro Bay estuary as a net source for sedimentation (t-test, p=0.003) and a net sink for phytoplankton production (t-test, p=0.000). Despite Morro Bays national recognition, little work has been done to assess the loss of aerial extent of the estuary. Based on these results, assumptions can be made about possible terrestrial sources of sediment load and appropriate management practices.

OS22B HC: Hall III Tuesday 1330h

Interactions Between Macro- and Microorganisms in Aquatic Sediments III

Presiding: **R Haese,** Utrecht University**; E Kristensen,** Odense University**; J Kostka,** Florida State University

OS22B-170 1330h POSTER

Fluorescence of Pore Water Dissolved Organic Matter in Shallow Water Marine Carbonate Sediments as a Function of Seagrass Density

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Pore waters from shallow water carbonate sediments in the Bahamas were collected over a period of three years on a seasonal basis (winter and early summer) to examine the factors controlling sediment organic matter remineralization. Sediments at these sites range from bare ooitic sands to sediments underlying dense seagrass meadows (*Thalassia testudim*). In this study, pore water samples were analyzed for their fluorescence properties using EEMS (excitation - emission matrix spectroscopy) focusing on humic-like and protein-like peaks observed in such fluorescence spectra. Dissolved organic matter (DOM) fluorescence in shallow water carbonate pore waters showed an overall increase with depth over the upper 20 cm of sediment. This is similar to that seen in siliciclastic estuarine and shelf/slope break sediments. However, in the interval from the sediment-water interface to approximately 2 cm depth, only minor depth changes were observed in the shallow water carbonate pore waters relative to gradients deeper in the sediment. This may indicate the possible occurrence of advective mixing of pore waters and bottom waters in these surface sediments.

DOM fluorescence was observed to be a function of seagrass density at these sites. Sites with high seagrass density showed the largest fluorescence values, while sites with no seagrass (ooitic sands) showed the smallest fluorescence values. Furthermore, dense seagrass sites showed seasonal trends in DOM fluorescence, with winter samples having lower fluorescence values than summer samples. The fluorescence/DOC ratio was also lower in shallow water carbonate sediments as compared to siliciclastic estuarine and shelf/slope break sediments. Further examination of the data will involve using it in an attempt to differentiate between types of DOM present in the sediment pore waters (terrestrial versus marine) and examine the degradation and remineralization mechanisms affecting both DOM and total organic matter. We will also use the data to specifically examine the role of seagrasses in the cycling of DOM in these shallow water carbonate sediments.