does not require assumptions (1) and (2) above. Our approach estimates E directly from P and R (i.e. E = P - R), thus the assumption about the C:L ratio is unnecessary. Moreover, since Pnew (expressed in the L currency) is quantitatively equivalent to the amount of L exported, our approach permits the independent computation of the C:L ratio in the exported material (as E/Pnew).

OS22R-04 1415h

A Novel Approach to Estimate the Export of Biogenic Carbon From the Euphotic Zone. 2. Model Implementation

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Over the past decade, various food web and biogeochemical models have been developed to predict the biological and biogeochemical responses of the upper ocean to a variety of environmental forcings, including those due to global climate change. Many of the models use estimates of f-ratio or new production (Pnew) to compute the export (E) of biogenic carbon (BC) from the upper ocean. The estimates of E from Pnew assume that (1) community respiration in the euphotic zone (R) is quantitatively equivalent to the part of phytoplankton net production (P) that is supported by the autochthonous supply of L (regenerated production, Preg), and (2) the ratio of carbon (C) to L (C:L) is the same in both the exported material and P. We present empirical evidence that is consistent with our prediction that these two assumptions are incorrect. For major ocean regions, we show that Preg is systematically greater than R, and the C:L ratio in the dissolved and particulate biogenic material is greater at depth than in phytoplankton within the euphotic zone. We propose an approach to compute both E (as E = P - R) and the C:L ratio in the exported material from P, R and Pnew, variables which are available for most ocean basins.

OS22R-05 1430h

Stirring and Mixing - Their Effect on the Marine Ecosystem

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The biology of the oceans plays a fundamental role in the carbon cycle. Ecosystem models of the ocean are required in climate models used to predict future levels of atmospheric CO_2 and its effect on global warming. The ecosystem models themselves need to be a fair reflection of the dynamics of the ecological system, which may vary in both space and time. The underlying theme of the present talk is that stirring and mixing of biologically active constituents cannot be ignored in the overall dynamics of the system, and that the 'tuning' of one-dimensional models to fit observations can often produce erroneous results.

Here we give an overview of recent research on the effects of fluid dynamical processes, in particular lateral stirring and mixing, on biological productivity. It is found that from the diffusive scale to supramesoscale, diffusion and straining by the flow can have an impact on the dynamics of the biology. The biological response is affected by not only the fluid dynamics but also the dynamics of the ecosystem itself. In certain cases the biology can evolve to a completely different state given heterogeneity in the system.

OS22R-06 1445h

Complexity in the Self-Organized Pelagic Marine Biological System

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The pelagic marine biological system (MBS) is considered here to be self-organized. This in turn encourages new conceptual and research approaches. The system is characterized by power-law and other nonlinear interactions between its components and processes in space and time. The MBS is driven by the physical and chemical processes of the ocean and its interfaces, and the organisms have evolved to take advantage of those processes. A major driving factor of the system is that of the power-law ocean turbulent processes of large to small scale, having a fractal dimension of D = 1.67. All scales have biological significance. The consequences are illustrated by three examples involving the food web. (1) The patchiness of northwestern Atlantic phytoplankton has a similar power-law fractal dimension to that of turbulence, being passively distributed by the turbulence. (2) Northwestern Pacific herbivore copepods graze on phytoplankton and have a patchiness with a higher fractal dimension near D = 1.8, the result of turbulence and swimming by random walk. (3) Eddies can be considered to be semi-contained ecosystems, in essence self-organized; Antarctic krill swarms are inferred to be partially organized by ocean eddies (D = 1.67), upon which is superimposed feeding behavior involving swarming, with the swarm sizes having a fractal dimension near D = 1.9. Present numerical and box modelling approaches give significant insights into many aspects of the functioning of the MBS. But these approaches are hampered by their necessarily specialized conceptual frameworks, the need to use linear approximations of the non-linear processes and relationships, and limitations in available computer power. The present stepwise progress is one necessary approach to dealing with the inherent complexity of the MBS, but an overall strategy has not yet evolved and gaps exist. For example, the models need to be developed to reflect adequately the self-organizing nature of the system, and the size-scaling and energy/mass budgeting in the food web; also the gelatinous organism component of the food web is inadequately understood and modelled. Nevertheless important progress is being made, though stepwise, and the paradigm change is moving swiftly.

OS22S HC: 319 A Tuesday 1330h

Biogeochemical Linkages Between Rapidly Urbanizing Coastal Watersheds and the Coastal Ocean II

Presiding: **E H De Carlo,** University of Hawaii at Manoa**; K J Spencer,** Los Alamos National Laboratory**; F T Mackenzie,** University of Hawaii

OS22S-01 1330h INVITED

Diurnal to Decadal Variations of Trace Element Concentrations in San Francisco Bay: The Urban Estuary

A. Russell Flegal[1] (831-459-2093; flegal@etox.ucsc.edu); Sharon Squire (831-459-2088; ssquire@es.ucsc.edu); Douglas Steding (831-459-2088; dsteding@es.ucsc.edu); Christopher Conaway (831-459-2088; cconaway@es.ucsc.edu); Kuria Ndung'u (831-459-2088; kndungu@es.ucsc.edu); Genine Scelfo (831-459-2088; gms@es.ucsc.edu)

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A systematic investigation of contaminants in San Francisco Bay over the past decade has revealed pronounced spatial and temporal variations in its trace element concentrations in this, the "urban", estuary. Historic inputs of industrial lead over the past 150 years now account for most of the lead within the estuary, based on stable lead isotopic composition and mass balance calculations. The resultant model for the biogeochemical cycle of lead in the Bay is consistent with Turekian's original model for trace elements in estuaries, which was primarily derived from Pb-210 analyses in other embayments a quarter of a century ago. While we have not been able to definitively identify the origins of other trace elements within San Francisco Bay, using similar isotopic composition analyses, we have been able to resolve subtle decreases in some of their concentrations over the past decade, in spite of their much larger seasonal and episodic short term variations, using time series models. These models have also independently corroborated the results of our stable lead isotopic composition measurements. In toto, these analyses demonstrate that both systematic, long term data sets and rigorous geostatistical analyses are required to accurately quantify anthropogenic perturbations of natural biogeochemical cycles in estuaries and other, highly dynamic, coastal waters.

OS22S-02 1345h INVITED

Boron Isotopes as Tracers of Groundwater Sustainability and Anthropogenic Contamination in the Urbanizing Coastal Corridor

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The sustainability of groundwater resources and the discharge of anthropogenic contaminants to estuaries and the ocean are arguably the most important issues facing policy makers along rapidly developing coastlines. For example, groundwater salinization is rapidly becoming the common result of excessive drawdown of fresh water reserves from coastal aquifers. Potential sources of saline water include intrusion of present-day seawater, infiltration of agricultural effluents, and upwelling of brines of both marine and non-marine origin. Distinguishing between these sources of saline water is complicated, yet early detection and characterization of the salinization process is critical for the development of proper remediative aquifer management strategies. Similarly, contamination of estuaries and the adjacent ocean through discharge of agricultural effluents and "urban runoff" is essentially an unavoidable consequence of coastline development, although quantifying the extent of the anthropogenic impact is problematic at best. Boron isotopes can provide a unique and especially powerful tracer of these important processes at the ocean-coastline interface, precisely due to the juxtaposition of marine and non-marine environments in this setting and the conservative geochemical behavior of boron. The nearly 60 per mil difference in $^{11}B/^{10}B$ ratio between relatively light non-marine evaporites, the typical source of anthropogenic boron in detergents and fertilizers, and relatively heavy marine brines provides the broad context for distinguishing contributions from potential end-members in both groundwater and surface water systems. Numerous examples from our current ongoing work demonstrate that boron isotope tracer techniques provide an exceptional tool for monitoring the impact of development on the urbanizing coastal corridor, particularly when used in a multi-tracer approach that incorporates other isotope and geochemical parameters.

OS22S-03 1400h

Variability of heavy metal concentrations during storm-events in streams of a subtropical watershed

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Storm-generated freshwater pulses, or freshets, represent one of the primary mechanisms by which terrestrial material can be transferred from the land to the coastal ocean in a subtropical environment. As urbanization broadens its reach, freshets can become very important in the transport of anthropogenic material, especially with respect to non-point source pollution (i.e., street runoff). Typically elevated in concentrations of heavy metals such as Pb, Zn, and Cu, this anthropogenic input may have a deleterious effect upon estuarine and near-shore biological communities, as well as degrade the quality of stormwater.

The presence of steeply sloped watersheds and intense and episodic rainfall in the Hawaiian Islands creates an ideal scenario for the study of event-based transport of terrestrial mass. Moreover, the intersection of watersheds with increasingly urbanized areas, particularly in Honolulu, provides the opportunity to examine the effects of anthropogenic activity upon heavy metal concentrations during storm-events. Spanning both conservation and urban areas, a network of stations has been established in streams of the Ala Wai Canal Watershed on southern Oahu and in streams of the Kaneohe Watershed on eastern Oahu to examine short-term and annual variability in terrestrial mass transfer. The presentation will largely focus on data collected during 9 storm-events in the Ala Wai Canal Watershed with preliminary data from 1 storm-event in the Kaneohe Watershed also discussed.

Though both dissolved and particulate phases show variability in heavy metal concentrations during storm-events, particulate concentrations in the watershed, as expected, are much larger than that observed for the dissolved phase. Particulate Pb, Zn, Cu, Ba, and Co display patterns of elevated concentrations in the lower, more urbanized, watershed, while solid phase As exhibits higher values in the conservation areas of the upper watershed. Concentrations of Ni, V, and Cr in suspended particulate matter show a relative invariance throughout the watershed with similar values observed in both urban and conservation areas. Examination of a "Kona" storm (offshore low-pressure system) reveals

that the downstream transport of unimpacted matter from conservation areas results in an approximately 2-fold dilution in the concentrations of Pb, Zn, Cu, and Ba in the urban watershed.

URL: http://www.soest.hawaii.edu/~edecarlo/indexa.html

OS22S-04 1415h

When Predictive Models Fail: Testing the Accuracy of Oahu's Reef Corals as Predictors of Metal Concentrations in Seawater in Locations Subject to Varying Anthropogenic Inputs.

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We undertook studies of the chemical and lead (Pb) isotopic compositions of reef corals offshore of Oahu, Hawaii in order to establish the fate and transport of nonpoint source metal pollution in urbanized Hawaiian coastal waters. Using aragonite-seawater Kd's, we hypothesized that absolute metal concentrations, trends, and changes due to economic or regulatory impacts on human activity could be read from the coral reef record.

Metal concentrations and Pb isotope measurements were therefore taken on coral samples from several offshore sites spanning heavily impacted urban to lightly impacted rural conditions. Direct sampling of these same parameters in seawater and urban storm runoff, and measurements of Pb isotopes in juvenile fish otoliths provided independent tests of chemical parameters calculated from coral data.

Stable Pb isotope ratios measured on seawater samples and in otoliths spanned a 206Pb/204Pb range18.32 to 19.42, while measurements on corals collected at the same locations ranged from 18.32 to 18.52. The restricted range of Pb isotopes measured in corals strongly resembled our data measured on storm water samples and in urban sediments, strongly suggesting that these corals accumulated most of their Pb by incorporation from storm-derived particles.

Dissolved Pb concentrations were overpredicted by coral concentrations where coral and water isotopic compositions were most dissimilar. In areas where coral and seawater exhibited greater isotopic similarity, seawater Pb concentrations were predicted accurately. Dissolved elemental concentration predictions (Pb, Zn, Cu, Cd) varied in accuracy, with the level of agreement between coral-predicted and actual dissolved load concentrations in the order Pb (greatest agreement), Zn, Cd, Cu (worst agreement).

While historical trends are evident in many of the trace metal profiles in our corals, these may not reflect any simple measure of water quality (i.e. dissolved load). A range of factors, such as proximity of colonies to sedimentary input during storms, tidal or current generated mixing, and mode of metal incorporation may influence the relationship between coral and seawater trace metal concentrations. Efforts to use corals as proxies for seawater chemistry in "real world" situations must be used with caution.

OS22S-05 1430h

A Comparison of Sediment Contamination Legacies from Catastrophic Events in Pearl Harbor, Hawaii and New York Harbor, New York.

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Catastrophic events, such as intense storms, dam removals, nuclear accidents, industrial releases, or bombing attacks have major impacts on estuarine biogeochemical processes and environmental contamination. Particle deposition in estuaries and harbors is a principal mechanism for removing materials and particle-associated contaminants from linked watershed and coastal marine systems, and burial via sediment accumulation is the principal mechanism for isolating these materials from contact with epibenthic and pelagic biota. Elemental and contaminant profiles were measured in sediment cores collected in Pearl Harbor and New York Harbor, and were dated using vertical distributions of Be-7 (53-d half-life); Cs-137 (30-yr half-life); and excess Pb-210 (22-yr half-life). Results for Pearl Harbor indicate that the bombing attack on 7 December, 1941 had a major impact on water and sediment quality, contributing inputs of lead (and other trace metals) that greatly exceed total inputs from natural or anthropogenic sources (sewage discharge or naval operations) during the subsequent 50 years. Results for New York indicate that the removal of an urban dam (near Albany) in 1973, contributed significant quantities of PCBs to the lower Hudson estuary and New York Harbor, severely impacting water and sediment quality. Sediment cores collected in New York Harbor after the 11 September, 2001 terrorist attack indicate that short-lived Be-7 and I-131 (probably from hospital sources) serve as unequivocal indicators of material that has been deposited on a time scale of days to 6 months, and can be used to quantify short-term sediment dynamics (supply, deposition, re-suspension, focusing, and net accumulation). In addition, Ca/Al ratios serve as a fingerprint for materials deposited immediately following the bombing attack in Pearl Harbor and a similar fingerprint may also exist in New York Harbor as a result of the terrorist attack on the World Trade Center.

URL: http://www.es.umb.edu

OS22S-06 1445h

Short-term Sediment Dynamics in the Lower Hudson River Estuary: Identifying the Impact of the World Trade Center Terrorist Attack

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A wide variety of materials and contaminants are introduced into the Hudson River estuary, either directly via riverine, atmospheric, or marine sources; or indirectly, through its use for waste discharges and stormwater runoff, for cooling purposes in electric power production, or as a commercial harbor. Since many chemically reactive pollutants become associated with particles (aerosols, ash, soils, sediments and suspended matter in turbid estuarine waters), particle deposition in protected low-energy areas (such as abandoned harbor slips along lower Manhattan) is one of the principal mechanisms for removing particle-associated contaminants from harbor waters and burial via sediment accumulation is most likely the principal mechanism for isolating these materials. Using a suite of geochemical tracers that have known sources and input histories provides a powerful tool for quantifying the dispersal and fate of fine particles and contaminants in estuarine systems. Previous studies have noted that extreme, episodic events, such as the 7 December 1941 attack on Pearl Harbor, can leave a legacy in the form of a distinct layer of materials in sediment core profiles in coastal areas. The 11 September 2001 terrorist attack on the World Trade Center in New York City introduced large amounts of ash and debris over a wide area including New York Harbor and the Lower Hudson Estuary. On 12 October 2001, three sediment cores (40-50 cm long) were collected in abandoned harbor slips along the lower west side of Manhattan. In addition, soil core and ash samples were collected in and around the attack site. Radionuclide (Be-7, Cs-137, I-131) inventories and profiles, contaminant distributions, and particulate (major- and trace-element) characterizations were measured in these samples in order to: 1) investigate short-to-medium term sediment dynamics (supply, deposition, re-suspension, and net accumulation) in New York Harbor associated with extreme events and dredging; 2) quantify rates of recent sediment and contaminant accumulation in abandoned harbor slips along lower Manhattan; 3) identify a geochemical fingerprint of the atmospheric and storm-water input of dust, debris, and contaminants from the Trade Center Attack in surface sediments; and 4) evaluate whether this signature could be used with short-lived radionuclides to assess the impact of the attack and also serve as a tracer for short to medium term sediment dynamics in the Lower Hudson River Estuary.

URL: http://www.es.umb.edu

OS22S-07 1520h

Oxygenation of Contaminated Marine Sediments and Heavy Metal Mobilization

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Sulfide (S(-II)) controls heavy metals solubility (e.g. Cu, Zn, Pb, Ni, Cd) in anoxic marine sediments through their precipitation as metal-sulfides (MS) when total labile sulfide (LS) is present at higher concentrations than total labile heavy metals (LHM). At any point in time, a comparison of LS with LHM may thereby serve as a reasonable indicator of the mobility and bioavailability of heavy metals in a given sediment. However, MS are thermodynamically unstable in the presence of oxygen, and the oxidation of S(-II) should liberate precipitated metals, releasing some fraction to the dissolved phase and shifting the remainder into other solid-phase complexes. Past studies interested in MS oxidation during short-term resuspension events found that, while FeS oxidation occurs quickly, the oxidation of other MS was minimal during short-term experiments (8-24 hours).

We hypothesized that sediment oxygenation over longer time periods (e.g. due to improved sediment and water quality in polluted systems) does cause significant MS oxidation, and that this MS oxidation is in part biologically-mediated. We will present results from 15-day experiments in which changes in solid-phase and dissolved chemistry of Cu, Zn, Ni, and Pb were monitored during the oxygenation of metal-contaminated sediments from a coastal Superfund site (New Bedford, MA, USA). At t = 0, greater than 98% of the metals were present in the HCl-extractable (1 M; targets amorphous sulfides, amorphous Fe(III)-oxides, carbonates, Mn-oxides) and concentrated-HNO3-extractable (targets metals coprecipitated with pyrite) phases. After two days of oxygenation, 10-25% of total sediment-bound heavy metals were shifted from from HCl and HNO3 extractable phases into the more loosely-bound, ion-exchangeable fraction (1 M MgCl2). In addition, approximately 25% of the initially solid-bound Zn was released to the dissolved phase during this time. Significant increases in dissolved Pb, Cu, and Ni concentrations were also observed; however the mass of each of these dissolved metals represented approximately 1% of their respective total. The relative importance of biologically-mediated and abiotic mechanisms will also be discussed.

OS22S-08 1535h

Determination of Metal Speciation in Aquatic Ecosystems Using Equilibrium Gel Samplers

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Difficulties in measuring metal speciation in aquatic ecosystems include labor intensive methodologies and the fact that speciation can be determined for only one metal at a time. Gel-flux samplers have recently been developed as a means of measuring metal speciation in-situ. The samplers are based on measuring the flux of 'labile' metal species through a gel layer onto a bed of a metal binding resin (usually Chelex-100). The 'labile' metal species determined with this sampler include not only the free metal ion, but also organic and inorganically complexed metals that dissociate on time scales similar to the rate metals are depleted from the gel-solution interface. This type of sampler measures a form of metals immediately available for partitioning amongst different phases, including biological uptake. However, it may not provide an unequivocal estimate

of the free metal ion concentration in the surrounding solution. Also, since the concentrations of all metals at the gel-ligand interface are equal to zero, the sampler also may not reflect the competition amongst metals in complex mixtures for complexation to finite binding sites such as biotic ligands governing metal uptake into biological organisms.

We have developed a sampler based on the equilibration of immobilized ligands held in polyacrylamide gel with the free metal ion concentration in the surrounding solution. The disks, 1cm in diameter x 1mm thick, are impregnated with a metal binding resin (Tosohaas Toyopearl) at a concentration that can equilibrate with the surrounding solution on a time scale of hours, and can collect measurable levels of metals with minimal depletion from the surrounding solution. A procedure based on the complexation of a semi-conservative cation such as Mg can correct for the effects of pH, salinity, or the presence of competing metals on uptake into the gel. Results for copper in artificial seawater solutions of varying salinity, pH, and levels competing metals show agreement between actual and theoretical uptake of copper into the gel based on the free copper ion concentrations in the surrounding solution. Because the uptake of metals into aquatic organisms is a function of competitive interactions of metals, it is hoped that this sampler will also mimic the uptake of metals into biological organisms. Future experiments will examine the correlation between metals taken up by the sampler with metal uptake in fish.

OS22S-09 1550h

Partitioning of Trace Metals Between Particulate, Colloidal and Truly Dissolved Fractions in a Polluted River: the Upper Vistula River (Poland)

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The high industry densities in the Upper Vistula River basin make the river one of the most important polluted river in Europe. The metal partitioning depend on the physical-chemical conditions of system and can be affected by anthropogenic inputs. In this study, we report the results of trace metal partitioning between particulate (>1.2 micron), colloidal (1.2 micron 1kDa) and truly dissolved (< 1 kDa) fractions in the polluted riverine section compared to the non polluted headwaters. It was found that the salt input in the Vistula river induced the decrease of colloid concentration and the increase of SPM. Compared to upstream from the polluted section, the metal concentrations (Co, Cu, Cr, Mn and Zn) in the colloidal fraction were lower. It was mainly due to the rapid colloid coagulation at increased salinity, the competition with ligands and major ions (Ca and Mg) and the weak mobility of metals associated at the pollution sources with particles.

OS22S-10 1605h

Speciation of Hg in the Venezia Lagoon using Ultra-Clean Sampling and Analysis

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Venezia and its lagoon are, simultaneously, one of the cultural wonders of the world and a sensitive marine estuary under stress due to centuries of anthropogenic pollution. Although many studies have dealt with problems related to environmental pollution, practically no comprehensive research has been undertaken to explore the biogeochemistry of Hg within this fragile ecosystem. This is particularly surprising, given that the western side of the lagoon is bordered by the Marghera Industrial zone, which houses many industries that have discharged wastes directly to the lagoon since before world war II. Although many wastes contain Hg, of particular interest is the presence of a mercury cell chlor-alkali plant, which operated with little or no pollution control from 1953 to 1985. Studies that were conducted in the 80s and 90s have shown high levels of total mercury (1-20 mg/kg) in the sediments off shore of Marghera, with levels decreasing to approximately 0.2 mg/kg in the more isolated northern lagoon. Hg is transported on fine pariculate matter into the Adriatic Sea, where elevated levels of up to 0.5 mg/kg have been reported in pellitic sediments outside the barrier island of Lido di Venezia. Based on deep core sections collected in these these earlier studies, background Hg concentrations in these sediments are expected to be approximately 0.05 mg/kg. No results for methyl Hg have ever been reported for any compartment of the Venice Lagoon ecosystem. Since the lagoon is shallow and poorly flushed, contains high sulfate, and high nutrient loadings from agricultural runoff and urban sewage, it is expected to act as a vigorous microbiological incubator for Hg methylation. In this paper, we will report the first findings of a synoptic survey of Hg and methyl Hg in water column, suspended matter, sediment cores, and select marine biota samples collected using ultra-clean sampling techniques during November, 2001. Samples were taken in areas ranging from the relatively unimpacted northern lagoon, through the urban waters surrounding Venezia and Murano, and up into the Marghera Industrial zone itself. Samples were also collected in the Adriatic Sea, just outside the barrier islands (during incoming tide) to provide a contemporary regional background for comparison. Because the lagoon is very shallow and vertically well mixed, the use of suspended matter tracks the local surface sediment concentrations, while also allowing the calculation of very accurate sediment/water distribution coefficients for Hg and methyl Hg. This paper also reports the results of studies which look at the mercury speciation and methylation potential for chemical waste pond solids (primarily alkaline mineral material from an historic alumina extraction facility) as they erode into the lagoon.

OS22S-11 1620h

Effects of Habitat Type and Size on Species Composition, Nursery Function, and Refuge Quality for an Estuarine Fish and Macroinvertebrate Community

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In the Chesapeake Bay, as in other estuaries, human activity and natural forces have altered shallow-water benthic habitats, fragmenting them and replacing them with other habitat types. Some suggest that the new habitats assume the ecological roles fulfilled by the original habitat types. The purpose of this study was to experimentally test the effects of habitat fragment size and type on species composition, nursery function, and refuge quality for shallow-water macrofauna. We compared the density of fish and macroinvertebrates among five habitat types that have been impacted by human activity in the Bay. Oyster reef, submerged vegetation (SAV), and woody debris have been declining in percent cover, while bare sediment and riprap (artificial shoreline armor) have been increasing. Most of the dominant species (8 of 11) preferred (occupied in highest densities) either SAV or oyster reef. Wood and bare sediment were occupied by some species, but never preferred. For most species, density increased with patch size in their preferred habitat. Two, however, were most dense in smallest patches. New recruits of most species were most abundant in SAV, suggesting a larger nursery role than the other habitat types. Oyster reef and SAV offered the highest degree of protection when tested for one prey species (grass shrimp). Neither nursery nor refuge function depended on fragment size. Although fragment size affects community structure, habitat type appears to be more important at the scale of our study. Results also indicate that the value of the five habitat types is species- and age-specific. Habitats that are increasing in abundance due to human activity (riprap and bare sediment) are therefore unlikely to adequately assume the roles of those habitats in decline.

OS31A HC: Hall III Wednesday 0830h

Bridging the Gap: From Molecular Biology to Marine Ecology II

Presiding: **G F Steward,** University of California, Santa Cruz

OS31A-01 0830h POSTER

Phylogenetic Analysis of Metabolically Active Heterotrophs in the Oregon Upwelling System

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The ability to link cell-specific metabolic activity with phylogenetic diversity is an important step towards identifying the role of microorganisms within marine ecosystems. The amount of cell-specific metabolic activity has been shown to vary more than the abundance of cells. Whether the variation in cell-specific activity is accompanied by a shift in the diversity of cells present or is a shift in the metabolic activity of each group within the community remains unknown. To address these questions, samples were collected during four sampling periods from May 2001 to October 2001 at a site 10 nm east of Newport, Oregon. Temperature, salinity, density, and fluorescence were measured concurrently with the water sample collection. Incubating the water samples with the fluorogenic redox compound 5-cyano-2,3-ditolyl tetrazolium chloride (CTC) indicated that 5% of the cells had an active electron transport system (ETS). Flow cytometry using the nucleic acid stain SYBR Green I indicated that small cells with high nucleic acid contents (SHNA) were the majority of the microbial community at depths below 40 m. Cells with low nucleic acid contents (LNA) were more prevalent immediately below the thermocline, while the large, high nucleic acid cells (LHNA) were less than 10% of the total heterotrophic microbial assemblage. Denaturing gradient gel electrophoresis (DGGE) of the V3 variable region of the small subunit ribosomal RNA gene was used to compare the diversity of whole seawater to cells with an active ETS (CTC+ cells). Furthermore, since other research has indicated that cells with high nucleic acid contents are responsible for the majority of bacterial production, whole seawater samples were compared to cells with different concentrations of nucleic acids (LHNA, SHNA and LNA cells). These data will examine the temporal variability in the diversity of metabolically active cells and examine whether all cells in marine systems are metabolically active or if only a subset of those cells are active at any one point.

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Molecular Probes of Sediment Stress in the Reef Building Coral Montastrea Faveolata

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A variety of stressors including high water temperature, sedimentation, changes in salinity, and exposure to UV radiation have contributed to a rapid decline of corals worldwide. Our work has focused on developing molecular biomarkers of sedimentation stress for the reef building coral Montastrea faveolata. Stressors cause a remodeling of gene expression by regulating specific genes. We used subtractive hybridization, differential screening, and sequencing, to identify coral genes up regulated in response to sedimentation stress. Techniques for extracting RNA from coral produced between 1000 to 4000 ug of total RNA, and approximately 0.4 to 1 percent of message RNA per 40 centimeters squared of coral tissue. A cDNA library of genes was created and 96 colonies were screened, with 15 to 20 percent showing differential hybridization. Further screenings demonstrated that 1 to 3 percent of the original colonies exhibited differential expression. These genes were further processed for probe development. By identifying and monitoring these genes in the field, we can estimate stressor impact, and rank stressors according to their effects. The probes could also be used to compare regions of high sediment stress to low stress areas, and to compare sediment stress to other stressors impacting corals.