ABSTRACT BOOK

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TOWARD RESILIENT COASTS AND ESTUARIES, SCIENCE FOR SUSTAINABLE SOLUTIONS

3-7 NOVEMBER 2013 • SAN DIEGO, CALIFORNIA, USA

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THE EFFECTS OF GENETIC RELATEDNESS AND FUNCTIONAL TRAIT DIFFERENCES ON THE PERFORMANCE OF PAIRS OF EELGRASS (*ZOSTERA MARINA*) GENOTYPES

Genetic diversity within key species has been increasingly tied to the performance of entire communities. Most current genetic diversity studies use only the number of genotypes as a metric of diversity. However, because functional similarity among genotypes may be influenced by common ancestry, assemblages of more distantly related genotypes might perform better because they encompass a wider niche breath (complementarity). We explicitly tested the influence of genetic relatedness and trait distance on eelgrass (*Zostera marina*) performance by growing pairs of eelgrass genotypes with known pairwise relatedness and trait measurements in the field for a year. Surprisingly, multivariate trait distance between genotype pairs and pair relatedness were not significantly correlated. Genotypic richness, identity, and trait distance all interactively influenced the performance of eelgrass pairs. We found that, by the end of the experiment, one genotype had been excluded in 60% of the plots. Trait distance and genotypic identity both affected the rate of exclusion. Pairs with greater trait distance where more likely to have one genotype dominate, suggesting that similar genotypes may be competitive equals. Trait distance increased biomass accumulation, but only in plots where a single genotype remained. Presumably, some legacy of past interactions accounts for the differences in biomass. All plots where both genotypes persisted achieved similarly high biomass regardless of trait distance, suggesting complementarity when genotypes coexist. Pair relatedness was not correlated with biomass or exclusion rate, however leaf growth rate increased with relatedness in plots where only one genotype persisted. Our work shows that genetic diversity within eelgrass beds can be dynamic and complex. The identity and trait similarity of genotypes determines whether genotypes coexist, while the number of persistent genotypes and past competition influence performance.

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SEDIMENT TRANSPORT IN A COMPLEX ESTUARINE CHANNEL NETWORK

Located landward of San Francisco Bay, California (USA), the Delta is an inland channel network formed by the junction of the Sacramento and San Joaquin rivers. The Delta collects more than 40% of the total fresh water from the entire state of California and discharges this water seaward through San Francisco Bay and the Golden Gate, thus forming the largest estuary at the United States west coast. Several efforts have been made to estimate (historic) sediment dynamics within the Delta and the resulting supply to San Francisco Bay (Jaffe et al, 2007, Schoellhamer et al 2012, McKee et al 2006). Schoellhamer et al. (2012) developed a conceptual model for sediment transport within the Delta considering several biotic and abiotic forcing. So far, there is no numerical model robust enough to reproduce sediment transport within the Delta that is capable of making future predictions. Being part of the CASCaDE II project our aim is to reproduce the sediment dynamics in this system applying a process-based, numerical model (DFlow FM developed by Deltares) that couples the Delta and the Bay. The model domain is 150 by 180 km and has an 80.000 node 2D flexible mesh network with spatial resolution varying from 10m to 400 m. A typical run time is 1 day for a full year on an 8 node PC. Our effort is complementary to Martyr (abstract submitted). We are developing the same model in order to deliver a robust Bay-Delta model. We calibrated the model, for the water year 2011, using an extensive data set available for the Bay-Delta system to match observed water discharge, water level and suspended sediment concentration. We compared model results with the Schoellhamer et al. (2012) conceptual model for further sediment transport analysis in terms of fluxes and sediment budgets. This enabled us to determine major forcing mechanisms and the impacts of possible future scenarios of Delta water resources management.

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US FISH AND WILDLIFE SERVICE SALT MARSH INTEGRITY ASSESSMENT RESULTS FOR 2012: 11 NATIONAL WILDLIFE REFUGES FROM MAINE TO VIRGINIA

Salt marshes are extremely complex ecosystems, which are highly valuable to many wildlife species and provide a number of essential ecosystem services. In 2012, National Wildlife Refuges across the Northeastern US began researching the quality of their salt marsh holdings using a Salt Marsh Integrity (SMI) index. The purpose of SMI is to evaluate the current condition of federally managed holdings, identify parcels in need of restoration, and over time, determine the effect of management activities and of sea level rise (SLR). GIS-based land cover analysis, nekton sampling, vegetation sampling, rapid vegetation community assessments, point-counts of salt marsh obligate birds, surface elevation tables (SETs) and water level recordings are all part of the SMI assessment. Eleven Refuges from Maine to Virginia contributed data in 2012. The GIS-based land cover assessments quantified patterns of disturbance and land use that had previously been anecdotal. Comparisons of data across the region reveal no increase in nekton or plant species richness from north to south. Refuges with lower salinities due to tidal restrictions show greater invasive species presence. Water level loggers highlighted the effects of tidal restrictions and storm surges. Additional data collected in this and subsequent years will reveal any trends in nekton density and biomass, plant species richness and community composition, spread/control of invasive species, and changes in water levels. Finally, Structured Decision Making analyses using these data will help determine optimum management practices at each Refuge. As sea levels rise and human demand for ecosystem services grows, salt marshes are becoming an increasingly rare and important habitat. SMI will help us determine what needs to be done to preserve these vital areas and keep them functioning as wildlife breeding grounds, carbon sinks, water filters, and storm buffers.

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RESPONSES OF TEMPORARILY OPEN / CLOSED ESTUARIES TO CHANGES IN FRESHWATER INFLOW

Freshwater abstraction increases the duration and frequency of the closed mouth state in temporarily open/closed (TOCE), bar-built or barrier estuaries. The loss of the connection with the sea prevents tidal exchange reducing the zonation and diversity of estuary habitats and recruitment of marine invertebrates and fish to the estuary. Reduced mixing and increased water retention together with nutrient input leads to eutrophic and polluted conditions. Shifts from rooted submerged macrophytes to a eutrophic state where either microalgae or macroalgae are dominant have been noted. Understanding the responses of these estuaries to changes in freshwater inflow is important as the National Water Act (South Africa) requires that freshwater inflow is allocated to keep estuaries in a healthy state. Increasing population growth and demands on available freshwater resources in a semi-arid country presents challenges for the management of these dynamic systems. Environmental flow requirement studies have been completed on 25 TOCE estuaries and indicate that estuaries in urban areas particularly along the east coast are in a poor state whereas some estuaries in rural areas have good ecological state. Freshwater inflow requirements have been set to restore the health of these systems which in some cases translates to removal of water as a result of inputs from wastewater treatment works. The confidence level of these studies is frequently limited by the availability of good data. TOCEs have small catchments and react to daily changes in river inflow; these data are therefore needed to quantify the high degree of variability in these systems and set the environmental flow requirements. Because of their small catchments TOCEs are sensitive to land use changes and thus a holistic catchment to coast management approach is necessary which requires collaboration across government departments.

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INFLUENCE OF ENVIRONMENTAL FACTORS ON DIVERSITY AND ABUNDANCE OF MEIOFAUNA IN THREE FLORIDA ESTUARIES

Meiofauna have been used as biological indicators in estuarine and marine environments. They are also an important food source for meiobenthic predators and indirectly a food source for higher tropic levels. The current study is being conducted in three Florida Panhandle estuaries: St. Josephs Bay, Apalachicola Bay and Pensacola Bay to examine the effect of sediment organic matter quality (Carbon: Nitrogen ratio), sediment grain size, salinity and dissolved oxygen concentrations on meiofauna biodiversity. St. Josephs Bay is a lagoon system with no significant surface water runoff compared to Apalachicola Bay or Pensacola Bay. The Apalachicola River has the highest freshwater discharge of all Florida Rivers. Samples from St. Josephs and Apalachicola Bays were dominated by 5 groups of meiofauna; nematodes, polycheates, oligochaetes, harpacticoid and tardigrades. Nematodes were the most abundant across all stations at 625.43 individuals per 10 cm^{-2}, followed by Polychetes and Oligocheates with 40.75 individuals per 10 cm^{-2} and 32.41 individuals per 10 cm^{-2} respectively. Tardigrades were the least abundant across all stations with a diversity of 2.88 individuals per 10 cm^{-2}, across all stations. The ratio of C: N at two sites in St. Josephs Bay was 13 and 12, while meiofauna biodiversity at these two sites was 290.41 and 192.54 individuals per 10 cm^{-2}, respectively. However, in Apalachicola Bay the C: N ratio was high at 57 and 55, while the meiofauna biodiversity was low 120.65 and 124.83 individuals per 10 cm^{-2} for each site. Therefore, the results suggest that sites with low C: N ratio have better quality of organic matter which supports high meiofauna diversity. Previous C: N data from Pensacola Bay area varied between a high of 15.1 in the channel to as low as 1.8 within the Shoal. However, Pensacola Bay is historically known to have large hypoxia zones which may influence abundance and diversity of the benthic meiofauna.

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SUSTAINABLE SEAGRASS RESTORATION IN THE VIRGINIA COASTAL BAYS: MODELING DISTRIBUTION BASED ON LIGHT, TEMPERATURE, AND SEDIMENT CHARACTERISTICS

Restoration of eelgrass (*Zostera marina*) has been successful in the Virginia coastal bays, where >17 km^2 of eelgrass has been restored since 2001. In the regions where restoration has focused, water quality (as quantified by total suspended solids, chlorophyll, dissolved nitrogen) is high and sediments are sandy. Long-term monitoring of restored sites and modeling of sediment suspension and light attenuation have shown that the minimum depth for *Z. marina* survival in these bays is 0.9 m mean sea level (MSL) and the maximum depth is 1.6 m MSL. Understanding the effects of varying environmental conditions, such as sediment, water quality, and temperature on minimum and maximum depth limits for seagrass is important for extending restoration efforts to other regions in the Virginia coastal bays. High temperatures in shallow areas, increased light attenuation at deeper depths, and high sulfide concentrations in fine-grained sediments act as stressors in eelgrass meadows and may reduce potential areal coverage. We quantified changes in light attenuation and temperature from depths of 0.4 m to 2.0 m MSL in two unrestored bays, one with fine-grained sediment (Gargathy Bay) and the other with coarser sediment (Magothy Bay), and compared these with sites in a centrally located successfully restored bay (Hog Island Bay), in order to model the potential distribution of *Z. marina* in each of these bays. We then tested the model by comparing it to transplanted eelgrass survival in the unrestored bays. We found significant differences in the potential distribution for *Z. marina* growth in each bay, with Gargathy Bay being uninhabitable due to poor conditions and Magothy Bay having a slightly deeper range than Hog Island Bay. To isolate effects of sediment characteristics from light and temperature, we also transplanted eelgrass into sediment from each of the bays in mesocosms and measured photosynthetic stress using a Pulse Amplitude Modulated fluorometer.

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EVALUATING THE IMPACTS OF LAND COVER, LAND USE, AND CLIMATE CHANGE ON WATER QUALITY IN WEEKS BAY, ALABAMA

The ultimate goal of this effort is to create a decision support system (DSS) tool to evaluate and visualize the impacts of potential future land cover land use (LCLU) and climate changes on runoff and concentrations of total suspended solids (TSS), nutrients, and pathogens as well as water temperature and salinity in Weeks Bay, AL. Watershed modeling using the Loading Simulation Package in C++ (LSPC) was performed for all watersheds contiguous to the bay for LCLU and climate scenarios in 1992, 2003, and 2030. Remotely sensed Landsat-derived National Land Cover Data (NLCD) were used in the 1992 and 2003 simulations after having been reclassified to a common classification scheme. The Prescott Spatial Growth Model was used to project the 2030 LCLU based on current trends. Intergovernmental Panel on Climate Change (IPCC) of the future changes in temperature, precipitation, and sea level rise were used to create the climate data for the 2030 model simulation. The LSPC model simulations provided output on changes in flow, temperature, and TSS for discharge points into the estuary. These results were inputted in the Environmental Fluid Dynamics Computer Code (EFDC) hydrodynamic model to generate data on changes in temperature, salinity, and TSS on a grid throughout the bay. Statistical models were built to describe the relationships between several water quality variables (based on model and/or in-situ data) and watershed factors. Finally, a DSS visualization tool based on the statistical models was developed, which will allow end users to evaluate a variety of future LCLU and climate scenarios and their potential impacts on TSS, temperature, salinity, nutrients, E. coli, and fecal coliform in Weeks Bay.

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DEVELOPING A SALT MARSH BOOK FOR CHILDREN

"And the Tide Comes In…", is a children's book that is aimed at upper elementary school children (grades 3-5). The main story follows two girls who visit a salt marsh in coastal Georgia over the course of a week, slowly building up their knowledge of the ecosystem. Each page also includes a sidebar that highlights a specific organism or scientific concept, as well as a connection question to engage children. The book was developed for the Georgia Coastal Ecosystems LTER project and is part of the LTER Schoolyard Book Series, which has published several children's books to-date. As part of the project we also developed supplementary materials, tied to standards, for use by elementary school teachers (gce-schoolyard.uga.edu). The book has been broadly distributed to environmental educators throughout the southeast and is being used for field trips and in the classroom. It has also been highly recommended for public libraries. This talk will describe the publication process, the contributions from K-12 teachers in the development of both the book itself and the accompanying materials, and our strategies for distribution and follow-up.

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TRACKING DROUGHT AND SALINITY ON THE GEORGIA COAST

The State of Georgia has experienced three significant, multi-year droughts over the past 15 years. During most of that time period, the Georgia Coastal Ecosystems (GCE) Long Term Ecological Research Program has been monitoring salinity at 9 sites along the Georgia coast. This study examined the relationships between drought and salinity at these sites and explores the extent to which observed changes can be related to potential drivers of salinity. Monthly average salinity during drought increased at all sites, particularly in upstream areas: salinities at a brackish site that generally range between 2 and 3 increased to approximately 8. Step-wise multiple regressions found that salinity at two stations towards the upstream end of the Altamaha River estuary were best explained by discharge alone, which is in turn dependent on upstream land use and precipitation in the watershed. Salinity at all other sites in the study area also responded to discharge, but the best regressions included different combinations of the 6-month Standardized Precipitation Index for the region, local precipitation, and sea level. R2 values for these relationships ranged from 0.64 to 0.94 at the 9 sites. These relationships show the relative importance of different drivers of salinity, with river discharge in particular having a strong but varying influence on estuarine conditions. These results can also be used to explore how conditions will vary in response to changes in discharge, runoff, and sea level that are expected as the result of altered climate and land-use.

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APPROACHES TO ENSURE PROTECTION OF DOWNSTREAM ESTUARIES FROM NUTRIENT POLLUTION

More frequent and larger harmful algal blooms and hypoxic zones in estuarine and coastal areas emphasize the need to prevent and reduce nutrient pollution. Under the Clean Water Act (CWA), states and authorized tribes are responsible for developing water quality standards that contain numeric pollutant limits (criteria) set at levels that ensure the protection of the designated uses of their waters. In order to protecting estuaries and coastal waters from the effects of nutrient pollution, it is important to consider limiting nutrient pollution at the source, which is often tens or hundreds of miles upstream. In the implementing regulations for the CWA, downstream protection was addressed by specifying that water quality standards must ensure the attainment and maintenance of downstream water quality standards (40 CRF 131.10(b)). One way to ensure the protection of downstream waters within water quality standards is through the use of downstream protection values (DPVs). Downstream protection values are pollutant concentrations assigned at various scales (e.g. at the pour point of the whole watershed or subwatersheds or at every single reach) throughout the network of upstream waters that when met will ensure the attainment and maintenance of water quality standards in downstream waters. As a result, the DPV will apply in place of the upstream criteria if the applicable DPV is more stringent. EPA has put forward four approaches to derive DPVs –water quality simulation models, dilution models, a reference condition approach, and the use of the criteria of the receiving estuary. Thus, the main objectives of this poster are to address how to determine protective limits for a waterbody, describe how DPVs can be computed using the aforementioned approaches, and to compare their applicability based on data and resource availability. Furthermore, for those DPVs derived using water quality models, we plan to discuss how these can be applied to the upstream waters.

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HIGH-RESOLUTION ASSESSMENT OF SALT MARSH DEVELOPMENT IN RESPONSE TO SEA LEVEL RISE IN THE SOUTHEASTERN UNITED STATES

The stratigraphy and sedimentology of salt marshes record the history of sea-level rise along stable, passive margin coasts. New mapping tools (i.e., RTK GPS, multibeam sonars), when combined with traditional geologic techniques, provide the means to collect high-resolution data for both retrospective and predictive studies of marsh behavior, although outstanding questions remain about the use of some new methods in marshes (i.e., LiDAR). Groves Creek marsh near Savannah, GA, was mapped at cm-scale resolution (2.7 M points) and sampled with 0.5-6 m long cores. Stratigraphic, sedimentological and microfossil evidence illustrate that environmental conditions have changed significantly over the past few thousand years as sea-level has risen and estuarine marshes have developed, creating a distinct fining-upward sequence. Shell-rich lag layers define the transition from subtidal to intertidal environmental conditions, perhaps in response to storms. The upper meter of the sediment column reflects conditions similar to those at present: homogeneous, fine-grained (>85% mud) sediments, high organic carbon, short-term (7Be) and long-term (210Pb) accumulation rates pacing local recent sea-level rise (~0.3 cm/y) and δ13C values (-18.5‰) reflecting S. alterniflora input. In contrast, below a lag layer, deeper sediments are >80% sand, well-bedded and low in organic carbon. A comparison of RTK and LiDAR performance in the salt marsh demonstrates that the highest vertical errors are located in the non-platform, creek and levee zone where taller, more dense grass is observed (mean difference = 0.07 m, RMSE = 0.14 m). On the marsh platform where grasses are sparse, LiDAR- derived elevations were generally in good agreement with RTK-surveyed elevations (mean difference = 0.00 m, RMSE = 0.06 m), suggesting that LiDAR can be useful in some salt marsh settings.

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USE OF FLOW CYTOMETRIC APPLICATIONS TO RESOLVE RESPONSES OF NATURAL MICROBIAL COMMUNITIES TO NUTRIENT ENRICHMENT IN GALVESTON BAY, TEXAS

There are billions of diverse microbial cells in a liter of seawater including both eukaryotic and prokaryotic organisms. Marine microbes play significant roles in many biogeochemical cycles and are a major component of numerous marine food webs. Dynamic physical processes in estuarine systems lead to abiotically distinct nutrient regimes across temporal and spatial scales. Microbes adapt to shifts in their immediate environment that are reflected in changing community abundance, structure, production, interactions and functions. However, analyses focused on the combined responses of both autotrophic and heterotrophic microorganisms to nutrient enrichment have been limited. Flow cytometric techniques can be applied to examine these microbial groups simultaneously and provide insight into potential interactions. This study has generated a baseline of microbial group structure at two sites within Galveston Bay, Texas and identifies community responses to changes in ambient nutrient conditions. Nutrient enrichment mesocosms were conducted monthly on seawater collected and incubated under natural marine conditions. Experimental samples of 20µm filtered seawater and control samples of 0.2µm filtered seawater were obtained and preserved using 1% paraformaldehyde and 0.01% gluteraldehyde. Populations were resolved using SYBR Green I stain, autofluorescence parameters and forward scatter with a Flow Cytometer. Preliminary results indicate that an increase in nucleic acid content and abundance of heterotrophic microbes corresponds to increased pigmentation in the autotrophic community when exposed to limiting nutrients. The potential shift from autotrophy to heterotrophy in nutrient pulsed systems has broad implications for energy transfer to higher trophic organisms in estuarine environments. The use of flow cytometry can improve our understanding of variability in microbial communities and their interactions in marine systems.

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HOW WELL DO EMPIRICAL RELATIONSHIPS FOR ESTIMATING CARBONATE SYSTEM PARAMETERS IN THE CALIFORNIA CURRENT SYSTEM WORK IN THE SALISH SEA?

Both the northern California Current System (CCS) and waters of the Salish Sea are affected by strong, seasonal upwelling of nutrient- and CO2-rich waters along the Pacific Northwest continental margin. These ecosystems are characterized by intense biogeochemical cycling, with high rates of primary production, air-sea CO2 exchange, and carbon export to benthic and open-ocean environments. Retention and recycling of detrital organic material on the continental shelf and in enclosed water bodies such as Hood Canal in the Salish Sea exacerbate the acidification of coastal and estuarine waters. These features predispose ecosystems in the northern CCS and Salish Sea to being susceptible to lowered calcium carbonate saturation states from a combination of ocean acidification and natural processes such as upwelling and respiration. We have developed new relationships for characterizing the carbonate system (i.e., pH, calcium carbonate saturation states, carbonate ion concentration, dissolved inorganic carbon concentration, and alkalinity) based on proxy variables such as oxygen, temperature, and salinity. For this work, we have utilized three calibration data sets from coast-wide cruises in 2007, 2011, and 2012, along with several new verification data sets. We have successfully extended the relationships to the ocean surface and are subjecting the new relationships to rigorous verification. We are presently testing the use of these relationships in parts of the Salish Sea to determine whether this approach can be used, wholly or in part, along an estuarine salinity gradient. The relationships provide an important tool for reconstructing carbonate system parameters relevant to ocean acidification at times and places where the proxy data are available.

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IMPACTS OF INVASIVE-PLANT MANAGEMENT ON NITROGEN-REMOVAL SERVICES IN FRESHWATER TIDAL MARSHES

Management of invasive plant species such as *Phragmites australis* in order to conserve native plant diversity is a major management goal in the Hudson River Estuary. Substantial changes in plant community composition resulting from species invasions and the removal of invasive species may drastically alter sediment characteristics and processes, including permanent removal of nitrogen from these systems via microbial denitrification. The Nature Conservancy conducted small-scale removals of *Phragmites* from Ramshorn (also Catskill) Marsh of the Hudson River in September 2010 using glyphosate herbicide. Here we present results from a four-year monitoring project, including two years of pre-treatment monitoring, of sediment characteristics and potential denitrification rates for three herbicide-treated *Phragmites* patches, three untreated *Phragmites* sites, and adjacent sites dominated by native *Typha angustifolia*. Sediment ammonium increased following the removal of vegetation from treated sites, likely as a result of decreases in plant uptake and nitrification. Denitrification potentials were lower in removal sites, relative to untreated *Phragmites* sites, a trend that persisted two years following removal as native plant species began to re-colonize treated sites. With the exception of measurements conducted following Hurricane Irene in September 2011, denitrification measurements were consistently highest in *Phragmites*-dominated sites. This result suggests the potential for a trade-off between invasive-plant management and nitrogen-removal services. However, our results also reveal considerable interannual and interseasonal variation in denitrification, highlighting a need for more frequent intra- and interannual monitoring efforts in order to fully understand the dynamics of plant-sediment interactions, and their impacts on nitrogen cycling, in tidal marshes of the Hudson River.

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GULF COAST ECOSYSTEM RESTORATION SCIENCE, OBSERVATION, MONITORING AND TECHNOLOGY PROGRAM: ENGAGEMENT APPROACHES TO ENSURE RESEARCH PRIORITIES SUPPORT MANAGEMENT NEEDS

The Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program (the RESTORE Act Science Program), established by NOAA, will initiate and sustain an integrative, holistic understanding of the Gulf of Mexico ecosystem and support, to the maximum extent practicable, restoration efforts and the long-term sustainability of the ecosystem, including its fish stocks, habitat, and fishing industries through ecosystem research, observation, monitoring, and technology development. In 2012, Congress passed the RESTORE Act, which transfers 80% of all administrative and civil penalties paid by responsible parties in connection with the Deepwater Horizon incident to a Gulf Coast Restoration Trust Fund. The RESTORE Act also establishes several programs, funded by the Trust Fund, to aid in the ecological and economic recovery of the Gulf Coast states, including the Program. In addition to consulting with the U.S. Fish and Wildlife Service, the Gulf States Marine Fisheries Commission, and the Gulf of Mexico Fisheries Management Council, required by the Act, NOAA took further steps to ensure that identified research priorities support management needs that will provide the cornerstone necessary for a healthy, sustainable Gulf-wide ecosystem. These steps included outreach to all recipients of settlement funds derived from the spill money to support science activities thereby maximizing benefits to the environment and people of the Gulf of Mexico; maintaining an active dialog with a broad array of interested partner and stakeholder groups during the planning and implementation of the Program; and incorporation of action items from a number of previously developed and well vetted regional science plans, such as the Gulf Coast Ecosystem Restoration Task Force's Science Assessment and Needs. This presentation will review the program structure, purpose and approaches to engagement since the program's establishment in January 2013.

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TROPHIC AND NUTRIENT SUBSIDIES BY NEKTON IN A SOUTHEASTERN U.S. SALT MARSH ESTUARY

Nekton occupying tidal systems influence ecosystem structure and processes through their movements, foraging (bioturbation), feeding, and other activities. We have demonstrated that fishes and shrimps excrete measurable amounts of NH4 and PO4 in intertidal salt marsh creek-basins. The timing of peak nutrient releases results in a net import to the upper ends of creeks where nutrients may subsidize primary production and, by extension, prey of nekton. Nutrient subsidies by nekton vary with biomass over the seasons, but they occur year-round throughout the estuary. Spatial variations in nutrient contributions by resident and transient species are related to the hydrogeomorphological characteristics of the habitat, with order of magnitude differences in biomass densities possible between adjacent intertidal creek-basins. Ecological network analyses showed that food web structure and quantitative trophic relationships were associated with hydrogeomorphological features. Shallow, wide creeks had: (1) greater abundance, biomass, richness, and recycling rates of carbon, (2) higher trophic efficiency and flow through consumers, and (3) more export of carbon in the form of nekton than deep, steep-banked creeks. The latter tended to export carbon in the form of detritus and were otherwise opposite in most regards. Thus, the physical configuration of the habitat and its associated food web structure influence secondary production and the export of nekton biomass from salt marsh basins. Sea level rise, changes in river inflow and delivery of sediments, dredging, and human activities in surrounding watersheds can affect hydrogeomorphological features of habitat which can influence nekton behavior, production, elemental cycling, and subsidies on multiple spatial scales.

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EVALUATING RAIN AND STORMWATER NITROGEN INPUTS TO MISSISSIPPI SOUND: A LANDSCAPE APPROACH

Different nitrogen species were examined in rainwater and stormwater (SW) in three landscape types along Mississippi Sound: pristine, residential, and hardened. Integrated SW from drainage pipes that drain to Mississippi Sound were also sampled. Rainwater ammonium (NH4) concentrations were as high as 40 μM and had nitrogen stable isotope (15N) values that were isotopically light (-5 to -1) while nitrate (NO3) concentrations in rain ranged from 1 to 30 μM with 15N values ranging from -5 to +6. The range of rainwater dissolved organic nitrogen (DON) concentrations was similar to NH4 and NO3 concentrations (DON = 7 to 31 μM). NH4 concentrations from the pristine site SW were the lowest (0 to 13 μM) among the sampled sites and had 15N signatures that were more enriched than rainwater (-2 to +8). Pristine SW NO3 concentrations were much greater (0 to 71 μM) than NH4 and had 15N values that were unusually light. DON concentrations at the pristine sites were also higher than rainwater (17 to 51 μM). SW samples from residential and hardened sites were similar in terms of NH4 and NO3 concentrations (0 to 68 μM). 15N values for NH4 from these sites ranged from -8 to +17 per mil while 15N-NO3 values were much lighter. The range of observed DON concentrations in SW from residential and hardened areas (0 to 85 μM) were higher than that of NH4 or NO3. Integrated SW samples had a range of NH4 and NO3 concentrations that were similar to residential and hardened areas (0 to 54 μM NH4, 0 to 45 μM NO3) while 15N values of NH4 and NO3 were similar to the developed sites. The range of DON concentrations in integrated SW (0 to 34 μM) was lower than that at other SW sites and was similar to rainwater concentrations. Results show that there are spatially and temporally variable sources of both NH4 and NO3 to SW from different landscape types along the Mississippi Gulf Coast.

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PHYSICAL EFFECTS OF OYSTER REEF RUGOSITY: FLUME AND FIELD STUDIES IN A LOW-FLOW INTERTIDAL ENVIRONMENT

This study examines the role of topographical oyster reef rugosity on three-dimensional hydrodynamics in both field and laboratory settings in order to better understand reef geometry and the role it plays in oyster condition, feeding, and growth. Natural and constructed Crassostrea virginica oyster reefs in an intertidal mudflat were compared to constructed reefs in a laboratory flume. In the flume study, scaled reef models of varying rugosity were used to stimulate changes in reef surface roughness. Ranges of rugosity were compared to determine the effect on turbulent flow and the boundary layer over the reefs. Three-dimensional flow was described at a fine enough (5Hz) resolution to be able to delineate the effects of reef rugosity on water flow. Oyster reefs provide several significant ecosystem services in tidal creeks, including increasing productivity and nutrient cycling, improving water quality, acting as a buffer against storms and erosion, and creating critical habitat for a number of commercially important species, including the oysters themselves. This study examines the effects of oyster reef rugosity on flow and turbulence over the reef, how flow velocity and turbulence differ over reefs of varying rugosity, and describes differences in water flow, over and around the reefs, with respect to rugosity. This study compares data collected in the field with scaled models run in the laboratory flume to describe how flow properties change as a function of reef rugosity.

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HIGH-RESOLUTION, OBJECT-BASED MAPPING AND CLASSIFICATION OF COASTAL MARSHES IN RACHEL CARSON RESERVE, NORTH CAROLINA

Vast coastal wetlands of the South Atlantic coast are vulnerable to sea-level rise, erosion, wildfire, invasive species, and coastal squeeze development, but are wetland ecotones and physiognomic conditions detectable, identifiable, and accurate via remote sensing? This paper reports on the accuracy and feasibility for mapping high priority coastal marshes throughout the region. Multidate SAR imagery and LiDAR (vegetation canopy height and bare earth) are classified using object-oriented image analysis techniques and compared to classifications using traditional unsupervised and supervised techniques. Results quantify the accuracy achievable using combined SAR and vegetation canopy LiDAR for broad-scale mapping of coastal wetlands and highlight advantages and limitations of OBIA methodology for coastal wetlands. The temporal synchrony of satellite and airborne LiDAR and its vertical accuracy in wetlands is also evaluated in the context of classification accuracy. Advances in data fusion, classification and accuracy limitations, and potential time series analysis for coastal wetland monitoring are also described.

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ENHANCED LAND SUBSIDENCE AND SEDIMENT DYNAMICS IN GALVESTON BAY-IMPLICATIONS FOR GEOCHEMICAL PROCESSES AND FATE AND TRANSPORT OF CONTAMINANTS

Galveston Bay is the second largest estuary in the Gulf of Mexico. The bay's watershed and shoreline contains one of the largest concentrations of petroleum and chemical industries in the world, with the greatest concentration within the lower 15 km of the San Jacinto River/Houston Ship Channel (SJR/HSC). Extensive groundwater has been withdrawn to support these industries and an expanding population has resulted elevated land subsidence,

with the highest land subsidence in the lower SJR/HSC, of over 3 m (3 cm yr-1) and has decreased seaward throughout the bay to 0.6 cm yr-1 near Galveston Island. Mercury (Hg) contamination is well documented throughout the bay's sediments. Sediment vibra-cores were collected throughout the bay systems. 210Pb and 137Cs geochronologies from these cores was used to determine sedimentation rates and correlated to Hg profiles to estimate input histories. Relative Sea Level Rise (RSLR) is the sum of eustatic sea level rise and land subsidence. The results show sedimentation rates are high in areas with high rates of RSLR and the rates are of the same order of magnitude, however, in general, sedimentation rates are as much as 50% of RSLR, indicating that sedimentation has not kept pace with land subsidence, although they have the same relative order. Hg core profiles were correlated with radioisotope geochronologies and show significant input of Hg beginning around 1940, with a peak around 1971, and a dramatic drop off in concentration afterwards, demonstrating it to be a valuable geochronology tool. Hg concentrations were found to be dramatically higher proximal to the SJR/HSC and progressively decreasing seaward and to distal parts of the bay.

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HYDRODYNAMIC VARIABILITY OF NEARSHORE SHELF PROCESSES ALONG THE CALIFORNIA CURRENT EASTERN BOUNDARY REGION

Isla Natividad, Baja California Sur (27° 51' 09" N 115° 10' 09" W) is a narrow shelf area exhibiting many of the typical features of Eastern Boundary Upwelling Systems (EBUS). A dense array of instruments was deployed off the island's coast during the upwelling season 2013 measuring current velocity, water column temperature, salinity, dissolved oxygen, surface gravity wave as well as near-bed turbulence characteristics, pressure, and acoustic scattering. In addition to installing a local weather station to assess how these processes are influenced by large-scale climate variability. The high spatial and temporal resolution hydrodynamic data was collected to assess and analyze the forcing mechanisms of low dissolved oxygen (DO) events and wave-current interaction through the giant kelp forest (Macrocystis pyrifera). Potential low DO event patterns utilizing measured frequencies in the nearshore region are explored.

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CHALLENGING OF RESTORING SEAGRASS BED IN INDONESIA USING SEEDS

Enhalus acoroides is the climax species and the target species for restoration of seagrass in Indonesia. We studied the feasibility of maintaining a seed stock for Enhalus restoration and studied seed germination in three types of substrata (marine sand, coral rubble, and terrestrial sand) as well as the field. We found that marine sand was the best substrate to grow for the Enhalus seed. The Enhalus grew in marine sand had the longest leaf size and roots, also the biggest root diameter. In average, the performance of the seedling in the field is promising where the survival rate is 100% in 3 months period. However, treatment the Enhalus fruit (with the seed inside) with different length of storage and storage temperature (room and refrigerator) showed that Enhalus seeds did not survive well at longer storage period both in room temperature (~30oC) and in the refrigerator (4oC). The longest time seeds survived were 2 and 8 days in refrigerator and room temperature, respectively. Survival rate in the field was also correlated with the performance of the seedling when we raised them in the laboratory. There was 87.5% survival of seedling treated with 2 days storage in refrigerator, whereas all the seedling treated with 2 to 5 days storage in room temperature can grow well in the field (100% survival). However, stored the seed up to 8 days eventhough in room temperature did not show a good survival both in laboratory and in the field (survival was less than 20%). Our results indicate that long-term seed storage in the laboratory will not be feasible for restoration. Because using seeds for restoration is important for maintaining genetic diversity, the establishment of a seedling nursery in the field provides a viable alternative for Enhalus restoration, although it will be logistically more challenging than a seed storage bank.

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A COMPARISON OF STRUCTURED AND UNSTRUCTURED GRID MODEL PERFORMANCE IN THE IRISH SEA

Long-term resilience to future climate conditions and shoreline changes is crucial for the power generation and supply industry. This is of particular importance to the nuclear power sector, where coastal sites have operational life-spans exceeding 100 years. Two numerical models, the Finite-Volume Coastal Ocean Model (FVCOM) and the Proudman Oceanographic Laboratory Coastal Ocean Modelling System (POLCOMS), are compared to assess their suitability for assessing the future risk to key coastal locations, resulting from changes to sedimentation, erosion and flood risk in the nearshore, and the supply of cooling water. FVCOM is an unstructured-grid, finite-volume model with fully coupled waves and currents using the SWAVE wave model. POLCOMS is an established structured-grid model, coupled with the WAM wave model. The modelled area (the Irish Sea) was chosen to focus on a localised study area (a nuclear fuel reprocessing site) and to assess the full regional north-west (Carlisle – Anglesey) energy network resilience. Model performance at simulating waves and currents will be evaluated through comparison with data collected by the Irish Sea Coastal Observatory, and data from the UK National Tide Gauge Network and WaveNet. A 12-month simulation (1 January 2008 to 31 December 2008) from each model will be compared, following a three month spin up period of the baroclinic fields. We will show the importance of using a high-resolution mesh in the nearshore region. While both models validate well close to the coast, the flexibility offered by FVCOM's unstructured grid provides considerable benefits due to its ability to properly resolve ROFIs and estuarine systems without the need for further nesting.

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TOWARD UNIFIED FUNCTIONAL RELATIONSHIP OF SEDIMENT PICKUP IN COASTAL MODELS

Coastal sediment transport models cannot resolve all time and spatial scales, which leads to necessary parameterization of physical processes occurring at the unresolved scales. For sediment transport, this is especially pertinent for near-bed processes, and how these are represented is fundamental for the predictive ability of numerical models. In particular, accurate intrawave sediment pickup is critical for intrawave sediment transport in coastal environments. Classical sediment pickup functions essentially depend on the bed shear stress, which eventually results in dependence on near-bed velocity or near-bed turbulent kinetic energy. While this can lead to satisfactory intrawave predictions above flat beds, such approaches fail to reproduce suspension events linked to vortical processes at flow reversals, which are especially important above steep ripples. In recent years, high-resolution modeling of sediment transport and seabed boundary layer processes has resulted in better understanding of pickup parameterizations. There has, however, been relatively little work on the practical implementations in coastal models. We will build upon high-resolution results and investigate optimal parameterizations for sediment pickup above rippled beds. In particular, we will test novel approaches to pickup formulations. To that end, we will employ model-data comparisons of near-bed intrawave suspended sediment concentration to assess several parameterizations for sediment pickup. The data consist of measurements of suspended sediment by acoustic backscatter system (ABS) under full-scale waves in a large-scale wave flume. The model is implemented at a non-ripple-resolving scale and solves the two-dimensional Reynolds-Averaged Navier Stokes equations in order to provide temporal and spatial variations of velocity, sediment concentration and turbulence quantities.

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THE BIOAVAILABILITY OF GROUNDWATER DERIVED DISSOLVED ORGANIC NITROGEN

Long-term biweekly monitoring of groundwater in Gulf Shores, AL, indicates that 60 to 90 percent of the total dissolved nitrogen is in the form of dissolved organic nitrogen (DON). DON is assumed to be refractory and in nutrient budgets DON inputs from groundwater are often overlooked. Groundwater DON concentrations in Gulf Shores average 150 μM and exceed estuarine surface water concentrations by 1-2 orders of magnitude. Submarine groundwater discharge in the region has been identified as a driver for diatom dominated phytoplankton communities and has been suggested to contribute to potentially toxic blooms of *Pseudo-nitzschia* off the coast of Alabama. Bioassay experiments with groundwater DON, extracted using solid phase extraction cartridges, were conducted to quantify the fraction of

DON removed by both single species phytoplankton cultures and microbiota communities in coastal surface waters. *Chlamydomonas* sp. cultures grown in media amended with groundwater DON removed 20% of the added DON over a 14 day period, concurrent with increased chlorophyll concentrations compared to control treatments. Additionally, the surface water microbial community removed as much as 86% of the added DON during a 48 hour incubation. Oxygen consumption rates increased by 48% in treatments amended with groundwater DON. The removal of groundwater derived DON in both single cell phytoplankton cultures and surface water microbiota demonstrates the possibility for submarine groundwater discharge, containing high concentrations of DON, to influence microbiota communities.

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EVIDENCE FOR A BRACKISH TO HYPERSALINE PALEODEPOSITIONAL ENVIRONMENT, SAN ELIJO LAGOON, CALIFORNIA

Pore-water chemistry data were obtained from continuous cores of the upper 37 meters (m) of sediment beneath the San Elijo Lagoon near San Diego, California. These cores were collected during installation of a deep test well and pore-water samples were extracted from the bottom end of each core using a hydraulic press. The analytical protocol for the pore-water samples included major ions and stable isotopes of hydrogen, oxygen, and strontium. These data were combined with lithologic information collected during drilling and with 19th-century United States Coastal Survey maps of the Southern California coast to gain a better understanding of the natural environment of the San Elijo Lagoon over geologic time. Pore-water samples were highly saline throughout the Quaternary lagoonal deposits with chloride concentrations ranging from about 8,000 mg/L to over 73,000 mg/L. δ^2H and $\delta^{18}O$ isotopic values in the pore-water samples ranged from -34.9 per mil to -1.37 per mil and from -4.73 per mil to 1.01 per mil, respectively, with the most enriched δ^2H and $\delta^{18}O$ isotopic values coincident with the depth of the highest chloride concentration. $^{87}Sr/^{86}Sr$ isotope ratios ranged from about 0.70862 to 0.70954. Highly-saline pore-water samples with enriched δ^2H and $\delta^{18}O$ isotopic values and $^{87}Sr/^{86}Sr$ isotope ratios close to seawater provide evidence for brackish to hypersaline conditions beneath the San Elijo Lagoon. The Coastal Survey maps for the San Elijo Lagoon show the natural environment for this area during the 19th century consisted of seasonally-flooded salt flats without deep or permanent open water. These maps, along with the pore-water chemistry data and lithologic information from the continuous cores, suggest that the San Elijo Lagoon functioned as a seasonally-recharged shallow-water estuary for at least the last few thousand years.

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LONG-TERM TRENDS IN EUTROPHICATION OF THE BALTIC SEA

Based on a unique data set collated from research activities and long term monitoring, we review nutrient enrichment and eutrophication status in 20 offshore parts of the Baltic Sea. We classify eutrophication status over a > 100 year period using a multi-metric indicator-based assessment tool (HEAT 3.0) and assess confidence of the classifications made. Using chlorophyll-a as a proxy, special focus is put on identification of periods likely to include either an increase or a decrease in the production of organic matter sensu Nixon (2009). Our results are useful, not only in regard to an improved scientific understanding of eutrophication and oligotrophication trends in the Baltic Sea, but also in regard to further development of ecosystem-based nutrient management strategies, i.e. by setting the baselines for implementation of the Marine Strategy Framework Directives as well as the Baltic Sea Action Plan.

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REVIEW OF SURFACE AND GROUNDWATER DYNAMICS FROM LAND-MARGIN ECOSYSTEM STUDY (1996- 2012), EVERGLADES NATIONAL PARK, USA

A network of paired surface/groundwater gages was used to monitor hydrodynamic change across the land-margin in the southwestern mangrove estuaries of Everglades National Park from 1996 through 2012. We investigated how physical forcings of freshwater discharge, ocean exchange and atmospheric dynamics impact local surface and shallow groundwater and regional coastal land-margin. The network had upstream-to-downstream transects on the Shark, Lostmans and Chatham Rivers. Each transect had a paired surface/groundwater gage in a freshwater marsh, a mesohaline mangrove-marsh (ecotone) and a marine mangrove forest. Tidal exchange and seasonal freshwater discharge were the primary regional physical forcings, while rainfall and ET were more influential at the local scale. These coastal rivers have well-mixed estuaries with the highest average salinities (27.6 PSU) in the marine mangrove. Groundwater salinity had less variability than surface water, and peak seasonal groundwater salinity lagged behind peak surface water seasonal salinity by one to six months. Upstream water levels followed seasonal variability from rainfall and freshwater discharge and showed the greatest average difference in salinity (4.2 PSU) between local surface and groundwater, indicative of poor vertical exchange between the two water masses. Coastal water levels were correlated with diurnal and spring tide cycles; whereas, mangrove-marsh ecotone salinity and water level patterns were primarily influenced by a mix of spring tides, seasonal discharges and rainfall. Preliminary results suggest that a continuation of the network would be valuable to quantifying how the marsh-mangrove ecotone is influenced by changes in sea-level and upstream discharges resulting from Everglades hydrological restoration measures.

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IMPACTS OF CLAM AQUACULTURE ON BENTHIC MICROBIAL PROCESSES

Hard clam, Mercenaria mercenaria, aquaculture has grown dramatically in the U.S with increasing demands for an ecologically responsible, sustainably grown product. Because clam aquaculture does not require addition of food, ecosystem impacts are assumed to be small or even beneficial. By filtering phytoplankton derived from a large area clams remove nitrogen (N) and clarify water; however, when planted densely within a farm they both release dissolved N to the water column and biodeposits to the sediment with the potential for substantial detrimental local affects on sediment and water quality. Along Virginia's Delmarva Peninsula clam beds are covered with predator exclusion nets that are rapidly colonized by ephemeral macroalgae. Macroalgae provide a temporary ecological service by taking up N released by the clams and by decomposition of biodeposits; however, blooms tend to collapse by mid-summer and are periodically swept off of nets by growers and allowed to decompose in the estuary. The impact of clam aquaculture on N dynamics depends upon the relative rates of processes that remove N (denitrification and anammox) or that retain N within sediments (ammonification, and dissimilatory nitrate reduction to ammonium). A seasonal study of sediment and water quality, metabolism, nutrient fluxes, and N cycling rates was undertaken to assess ecosystem impacts of cultured clams in Cherrystone Inlet VA. Impacts were greatest during summer. Sediments within clam beds were enriched with N and organic matter and anoxic below 1.5 mm. Mineralization of organic matter resulted in accumulation of ammonium and sulfide. Nitrification rates were restricted by anoxic conditions; denitrification was substrate limited, and coupled nitrification – denitrification was likely inhibited by sulfide. During hydraulic harvesting of clams the accumulated ammonium and sulfide were released into the water column increasing the potential for eutrophication.

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THE EFFECT OF WINDS AND FRESHWATER DISCHARGE ON THE VARIABILITY OF CHLOROPHYLL A CONCENTRATION IN THE ESTUARY OF PATOS LAGOON (30S, BRAZIL)

Time series of hourly data on fluorescence were collected at the entrance of the Patos lagoon (PL). The fluorometer Turner Cyclops was connected to a RBR logger with conductivity and temperature sensors. The assemblage was installed at 5 m depth in a mooring in the main channel together with two temperature and salinity recorders that were measuring salinity and temperature at the surface and bottom (10 m). Near this area an acoustic Doppler current profiler was moored to produce hourly current velocity and direction profiles. The main objective of this study was to analyze the variability of chlorophyll a with respect to the wind action, freshwater discharge and the stability of the water column given by salinity vertical stratification. The results indicate that most of the variability is driven by the wind in the way it affects the exchanges between the lagoon and the coastal area in periods ranging from 3 to 20 days. Two main patterns have been observed: a) a chlorophyll a peak that is almost in phase with flood currents and salinity being tied to suspension and; b) a secondary peak that appears as the water started to be flushed out of PL. Its origin seems to be associated to the entrance of freshwaters derived from the drainage of Mirim lagoon, in the most vertically stratified part of the estuarine region, as indicated by a series of longitudinal transects obtained during cruises. The intensity of this second chlorophyll a peak depends on the residence time of salty waters being highest for periods longer than 4 days.

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EXAMINING THE ROLE OF OXYGEN AS A DRIVER OF MICROBIAL COMMUNITY STRUCTURE IN VEGETATED AND UNVEGETATED SALT MARSH SEDIMENTS AT SUB-MILLIMETER SCALES

Salt marshes play key roles in the cycling and removal of nutrients from the environment. These processes are mediated by microbial communities, and their metabolic activity, within the marsh. Many factors affect salt marsh microbial community structure, including salinity, carbon availability, and redox conditions. Redox conditions are particularly interesting because they determine what metabolic strategies are available to microbes. Here we investigate the role of oxygen, a key component in redox reactions, in determining microbial community structure. Prior studies have shown little evidence that oxygen acts as a driver of community structure, however, the resolution at which these studies were conducted may not have been fine enough to see its effect. To test the role of oxygen at smaller spatial scales, we use high resolution oxygen measurements and sampling techniques that give us 250 micron thick sections of sediments with corresponding oxygen concentrations. Next generation sequencing of these samples allows us to compare microbial community fingerprints above, within and below oxygen gradients in vegetated and unvegetated sediment cores. Although oxygen availability does not appear to be a driver of microbial community structure even at fine scales of resolution, microbial communities in vegetated cores differ from unvegetated cores and appear to differentiate into different communities as a function of depth in the sediments. This suggests that other factors, such as carbon exudates from plant roots, drives microbial structure in salt marsh sediments.

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RESTORING A SENSE OF HOPE: INVOLVING HIGH SCHOOL STUDENTS IN CONSERVATION

Increasing challenges of habitat loss, climate change, and the disconnect between the public and these issues provides environmental educators the opportunity to offer science-driven, solution-oriented activities. Point Blue Conservation Science (Point Blue) has made great strides towards addressing these issues through our community-based restoration program, Students and Teachers Restoring A Watershed (STRAW). This year we added a component to address these issues with high school students, an age group underserved by environmental programs. Focusing on climate change, ecological restoration, and the scientific method, we built a new science curriculum around one of STRAW's sites, the Hamilton Wetland Restoration Project in Novato, California. We engaged 150 high school students and 30 4th grade students. High school students worked with peers, professionals and elementary students in the field to plant native vegetation in a designated upland transition zone. In class Point Blue restoration specialists, biologists, and educators delivered lessons on wetlands, soil, climate change, ornithology and history of the Hamilton site. Students learned field skills to collect baseline bird and soil data to monitor ecosystem response to the restoration. Students followed Point Blue's standardized area search protocol during the waterbird surveys. Students sampled soil salinity and texture along designated transects. Next year students will collect data using the same methods, post levee breach. We assessed student progress and our ability to meet our objectives this first year by administering a pre and post-program assessment to all 150 high school students and leading a post-program pizza lunch discussion with a cross-section of students. Our goal by the end of 2014 is to develop a successful model to involve high school students in the solution to climate change and other environmental problems through habitat restoration and scientific monitoring.

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THE ROLE OF OYSTER MICROBIOMES IN NITROUS OXIDE EMISSIONS FROM OYSTER REEFS

Oyster gut and shell microbiomes may play a significant role in the production of the potent greenhouse gas, nitrous oxide (N2O), in estuarine and coastal ecosystems. N2O is produced through both nitrification and incomplete denitrification in the microbial nitrogen cycle. A preliminary study using Unisense probes was conducted to monitor N2O production and molecular oxygen consumption from live oysters and oyster shells during a 17-hour incubation period. In live oyster incubations, N2O rapidly increased as dissolved oxygen (DO) was depleted. Peak N2O production was observed when DO levels became anoxic. In shell incubations, N2O production steadily increased as DO decreased to 2 ppm and remained at hypoxic conditions. Increased N2O production during periods of anoxia and hypoxia suggest that incomplete denitrification may be the responsible pathway for N2O production in live oysters and oyster shells. 16S rRNA gene pyrosequencing analyses revealed a high percentage of proteobacteria in oyster gut and shell microbiomes. Within Proteobacteria, the gut microbiome was dominated by gamma proteobacteria Altermondales and the shell microbiome was dominated by alpha proteobacteria Rhodobacterales. Both families Altermondales and Rhodobacterales are comprised of several types of denitrifiers, which may involve incomplete denitrification. In addition, quantitative PCR assays revealed the lack of N2O reductase genes (nosZ) in oyster microbiomes. This provides additional evidence supporting the proposed hypothesis that incomplete denitrification is a major pathway of N2O production in oysters. Future research will be conducted to determine levels of N2O production from oyster reefs exposed to different anthropogenic and environmental influences.

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MANGROVE EXPANSION ON THE TEXAS COAST: IMPLICATIONS FOR BLUE CARBON STORAGE IN COASTAL WETLANDS

Carbon sequestered in marine ecosystems, termed "blue carbon," is an important component of the global carbon cycle. Coastal wetland contributions to blue carbon inventories are largely driven by the burial of organic carbon remaining after plant decomposition. Blue carbon stocks may therefore be sensitive to changes in plant community composition. On the Texas coast, black mangroves (*Avicennia germinans*) have been expanding into areas historically occupied by salt marsh plants. In this study, we quantified the magnitude of this expansion, and then investigated whether this vegetation shift might alter regional blue carbon stocks. We classified Landsat TM 5 images using artificial neural networks to quantify black mangrove expansion and salt marsh loss over a 20 year period on the Texas coast. Between 1990 and 2010, mangrove area grew by 16 km^2, a 74% increase, and marsh area decreased by 77.8 km^2, a 24% loss. However, less than 10% of the marsh loss was directly attributable to mangrove expansion; the majority of marsh loss was due to land use change or subsidence. We integrated soil organic carbon measurements to estimate changes in blue carbon storage along the Texas coast. Based on soil carbon accumulation rates over the last 100 years, organic carbon uptake in 2010 was 19% less than in 1990. However, mangroves and marshes have similar net organic carbon accumulation rates (~25-35 g C/m^2*yr), so this decrease was likely due to net wetland loss, and was not due to shifts in vegetation composition. Although woody encroachment of mangroves into salt marshes will likely change many coastal ecosystem functions, blue carbon storage capacity on the Texas coast will be mainly driven by habitat loss.

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OCURRENCE OF CRABS, SHRIMPS AND FISHES IN RELATION TO DAY AND NIGHT INTO SUBTROPICAL COASTAL LAGOONS FROM GULF OF CALIFORNIA

Day-night occurrence of swimming crabs, shrimps and fishes in a subtropical coastal lagoon from Gulf of California is presented. The specimens were collected with a trawl net, both day and night at 6 sampling stations, where temperature, salinity and dissolved oxygen were recorded in situ, on a monthly basis during two years in Las Guásimas lagoon. We used a nonparametric analysis of variance ($P<0.05$), and a Canonical Correspondence Analysis (CCA) to characterize the abiotic and biotic components. The swimming crabs Callinectes bellicosus (0.5 - 60 ind. ha-1), and C. arcuatus (0 to 38 ind. ha-1), were more abundant at night. The blue shrimp Litopenaeus stylirostris (1 - 13 ind. ha-1) was slightly greater during the day, and the brown shrimp Farfantepenaeus californiensis (1 - 27 ind. ha-1) was greater at night. The community of fishes was represented by 29 families, 53 genera and 74 species. Two groups were observed, one with affinity to the day, and another more important into the night, and this pattern was reflected in all seasons. The evidence suggested that biological activity during night is very important into subtropical coastal lagoons from Gulf of California.

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MODELLING OCEAN ACIDIFICATION IN MARGINAL SEAS: THE NORTH WESTERN EUROPEAN SHELF CASE STUDY

Variability of carbonate chemistry in marginal seas is often high due to their exposure to several concurring stressors such as air-sea CO_2 flux, river discharges, high biological activity and benthic-pelagic interactions. All these combined processes also make it more challenging to quantify the impact of ocean acidification in these regions as these processes can either exacerbate or mitigate the impact of the increasing atmospheric pCO2. The coupled physical-ecosystem model POLCOMS-ERSEM has been recently improved to take into account most of these processes and therefore to give a more realistic description of the evolution of carbonate chemistry. The model has been implemented in the North Western European shelf in two different set-ups: a hindcast (1970-2004), to assess present day spatial and temporal variability and trends presently occurring in the carbonate system, and climate forced (2080-2099 under the IPCC SRES-A1B scenario) to estimate long term impacts. The hindcast has been validated against in situ data derived from the CANOBA dataset, and it proves to adequately simulate most of the variables of the carbonate system. The evaluated model shows a high spatial and temporal heterogeneity in the carbonate system, with recent trends of acidification ranging between -0.001 and -0.003 pH units per year and high inter-annual variability. Similarly, the climate run evidences how ocean acidification can vary between -0.15 and -0.35 pH units in the annual mean surface pH, with high seasonal and inter-annual variability. The model can also be used to attribute the contribution of the different processes driving the carbonate system. This high variability can play a key role in defining the impact of ocean acidification on the biological compartment of the shelf sea ecosystem, we show how the interaction between warming, hydrodynamics and nutrient supply on one hand and the potential enhancement of photosynthesis under high CO_2 interact across the region.

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ASSOCIATING GENETICALLY DIVERSE TAMARISK INVADERS WITH THEIR IMPACTS IN A SALT MARSH ECOSYSTEM

Invasive tamarisk has many impacts in freshwater systems including increasing soil salinity, decreasing water content, and causing a shift in food web structure. Tamarisk species originally introduced to the U.S. have hybridized and have been documented invading salt marsh systems in San Diego County, California. The main goals of this study were to determine the abiotic and biotic impacts of tamarisk within a salt marsh and among genetic types of tamarisk. Amplified Fragment Length Polymorphism was used to determine genetic identity of each individual salt-marsh invading tamarisk. Abiotic impacts depended on microhabitat, as did tamarisk tree morphology, and infauna community composition. Tamarisk altered abiotic factors in the upland and upstream microhabitats. The tamarisk invasion had the most pervasive biotic impact on the infauna in the marsh microhabitat. 17.8% of trees were hybrids of *T. ramosissima* x *T. chinensis* . The remainder were pure *T. chinensis* . Tamarisk genetic identity did not influence abiotic factors, although invertebrate diversity was lower beneath pure *T. chinensis* than the hybrid. The introduction of hybrid tamarisk was not an in-situ hybridization because there were no pure *T. ramosissima* present at the site, rather they were most likely introduced from another site during rain and flood events.

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A COMPARISON OF AGE, GROWTH AND HATCH DATES OF JUVENILE ATLANTIC MENHADEN IN WARM AND COLD WINTER YEARS IN THE CHESAPEAKE BAY

Production of juvenile Atlantic menhaden, *Brevoortia tyrannus*, in the Chesapeake Bay has declined to historically low levels. The majority of larval menhaden ingress from shelf waters into the Bay during late fall and winter months. Recent otolith-based hatch-date analysis indicated that few juveniles result from this period of ingress, but rather originate from larvae produced during late winter and spring months. Because the Chesapeake Bay represents one of the northernmost nursery systems for juvenile Atlantic menhaden, we hypothesized that winter temperatures in the Chesapeake were sub-lethal, curtailing survival of early ingressed individuals. To test this, juvenile menhaden hatch dates and growth rates from warm winter years were contrasted with cold winter years to investigate whether warm winters favor higher growth rates and survival of juveniles following larval ingress into the Bay. We also examined a long-term survey of summertime juvenile abundances to evaluate the role of preceding wintertime conditions (temperature and chlorophyll-a). During 1995-2012, average winter temperatures ranged from 3.75°C to 8.5°C and exhibited an overall warming trend. When contrasting warm and cold winter years, we failed to detect a difference in hatch-date distributions. We observed higher growth rates in 2006 which were associated with high winter chlorophyll-a. Despite strong inter-annual variation in winter and early spring temperature and chlorophyll-a, there are no apparent trends in juvenile menhaden abundance as measured by the long-term survey. Although we failed to detect correlations between winter-time conditions and menhaden recruitment in the Chesapeake Bay, growth and habitat models for this species predict that future winter warming will affect juvenile production.

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CORRECTING SPATIAL BIAS IN WILDLIFE CITIZEN-SURVEYS: INTEGRATING MANATEE SIGHTING REPORTS WITH GPS TAG DATA

Species occurrence data collected by citizen volunteers or mined from historic records can supplement species distribution studies by adding dimensions of spatial and temporal survey coverage that may not be cost-effective or even possible for researchers to obtain otherwise. In the absence of rigorous survey or quality assurance methods, most citizen-collected or historic occurrence data may be biased in space to favor human population centers: species in areas of high human activity may be oversampled, while species in relatively unpopulated areas may not be adequately accounted for. We gathered citizen-reported occurrence data for the West Indian manatee (*Trichechus manatus*) in coastal Alabama, USA from 2007 to 2012. We found significant differences in spatial distribution between citizen-reported sightings and reference locations derived from GPS tag data from up to eight manatees in the study area. To correct for potential spatial biases in the citizen-reported dataset, we weighted each sighting report using a) population density of closest US Census block (2010), and b) aquatic distance to closest boat ramp. After correcting for spatial bias, the spatial distribution of citizen-reported sightings was nearly homogenous with reference GPS locations. These results provided a foundation to enhance our knowledge of manatee distribution within Alabama by supplementing GPS tag data with unbiased data not explicitly detected by GPS tags, such as manatee group size and behavior. These results demonstrate that species occurrence data collected under different methodologies may be corrected and integrated to form a more robust depiction of location and movement patterns for the species being surveyed.

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CONTRIBUTION OF SEAGRASS AND UPWELLING EVENTS ON THE CO_2 SYSTEM VARIABILITY FOR A MEDITERRANEAN COASTAL LAGOON

San Quintin Bay (SQB) is a coastal lagoon located in the Mexican Pacific, which is dominated by broad meadows of *Zostera marina* and prone to periodic upwelling events. The objective of this works, was study the effect of an area dominated by *Z.marina* on the CO_2 system, during and without the upwelling season and the subsequent biogeochemical changes. Measurements of Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), nutrients, salinity and temperature in surface water were carried out during spring tides. Higher values of Dissolved Inorganic Carbon (DIC) (> 2100 μmol kg^{-1}), pCO_2 (> 600 μatm) and NO_3^- (> 12 μM), were found for the outer zone where mixing processes control their distribution. The inorganic carbon concentration decreased toward the inner part of the bay (oxygen increase) about ~300 μmol kg^{-1}, but also pCO_2 and nitrate decrease, ~ 400 μatm and 10 μM respectively, towards the head of the BSQ. The former, indicated carbon removal by strong primary production processes where *Z.marina* meadows contribute greatly in combination of high residence time of the water. Our study indicates that, in the inner arm of the bay, biological mechanisms are the principal controlling factor of the CO_2 system. The biological processes mainly by *Z.marina*, make the inners areas effective carbon sinks even during intense upwelling. However, the inorganic carbon uptake is strongly dependant to the nitrate/ammonium availability from water upwelled by tides.

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GENOMIC RESOURCES OF THE AZTI'S MARINE BIOTIC INDEX SPECIES: AN ENDEAVOR IN FACILITATING MONITORING AND ASSESSMENT IN MARINE WATERS

Measuring the response of marine communities to environmental perturbations is a scientific challenge. Marine macrobenthos is a commonly used bioindicator, as these organisms reside in sediments, where contaminants accumulate, and have low mobility, which allows them to integrate environmental signals over a long period of time. The AMBI (AZTIs Marine Biotic Index) provides a measure of ecological quality status, based on the proportion of the five ecological groups into which the benthic species are classified. This classification requires a time consuming separation and identification of the samples by expert taxonomists. As an alternative, DNA barcoding has the potential to increase accuracy of benthic species identification and, combined with metagenetic analysis of bulk environmental samples, also to calculate the AMBI of a large quantity of sites in just a few days. Here, we present the resources available to develop a metagenomics based AMBI. Public databases have been interrogated for sequences of the universally used mitochondrial cytochrome oxidase 1 (CO1) and nuclear 18S ribosomal RNA (18S rRNA) genes of the >6000 species included in the most recent AMBI list. For each gene, alignments have been performed and the adequacy of universal and group specific primer pairs described in the literature has been assessed. Additionally, new sequences from key species of the AMBI for which no genetic resources were available have been obtained. If successful, the use of a 'genomic-AMBI' could represent a milestone in facilitating monitoring and ecological status assessment of marine waters.

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OYSTER REEF RESTORATION AND AQUACULTURE IMPACTS ON DENITRIFICATION AND THE BENTHIC COMMUNITY

Human impacts have greatly altered coastal ecosystems through a variety of processes including nutrient enrichment and overfishing. The negative consequences of these actions are well known and include increased macroalgae blooms, low oxygen conditions, and losses of biodiversity. Oyster restoration and oyster aquaculture are two possible mechanisms that might combat these changes. Specifically, oysters are thought to be 'hot spots' for reducing biologically reactive nitrogen (N) concentrations through denitrification (the microbial conversion of nitrate to dinitrogen gas). Additionally, oyster restoration and aquaculture may improve the abundance and diversity of nekton and benthic communities by increasing water clarity through filtration and enriching the sediments with pseudofeces. While oyster restoration is actively underway in many coastal systems along the Atlantic seaboard, the restoration methods for Narragansett Bay and Rhode Island coastal salt ponds continue to be developed. Our research is examining in situ rates of benthic denitrification as well as benthic invertebrate and fish diversity in four different environments in a coastal salt pond in Rhode Island. Specifically, we will report summer sediment oxygen demand and N2 gas and inorganic nutrient fluxes across the sediment-water interface at the following sites: oyster reef restoration, rack and bag aquaculture, shell hash, and bare sediments. Additionally, we will compare these in situ rates with other reported in the literature for other temperate shallow ecosystems.

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USING MATHEMATICAL MODELS TO SIMULATE COASTAL MARSH HYDROLOGY AND PRIMARY PRODUCTION

The coastal marshes of the Aransas National Wildlife Refuge (ANWR) are wintering grounds for the last naturally migratory population of whooping crane (Grus americana). Much effort has gone into furthering our understanding of how this coastal marsh ecosystem functions and to the long-term conservation of the whooping crane population. Previous work has suggested that the fruit of the Carolina Wolfberry (Lycium carolinianum) and blue crab (Callinectes sapidus) serve as primary food resources for cranes post-migration and that these food resources can be directly impacted by varying salinity throughout the coastal complex. In coastal wetlands, the use of mathematical models are an invaluable tool in assessing how different environmental conditions can impact ecosystem hydrology and primary production - without ever physically disturbing the crane habitat. Mathematical models that simulate marsh hydrology were constructed using both published and empirical data. Additional algal and soil samples were collected and analyzed to determine net and gross primary production and the phosphorus and nitrogen content. Linear regression analysis showed that 76.8% of the variation in net primary production is explained by salinity. This project was conducted by the newly formed ECO-IMPACS program. The data presented here serves as the foundation for future mathematical models that simulate shifts in whooping crane habitat quality as a function of seasonal environmental parameters.

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THE TRANSFERABILITY OF THE CSIRO ESTUARINE MODEL AROUND AUSTRALIA'S DIVERSE ESTUARINE AND COASTAL SYSTEMS

The Australian mainland has over 1000 estuaries, ranging from temperate saltwedge estuaries to intermittently open closed lagoons and flood-prone tropical rivers. Australia's national science agency, the CSIRO (Commonwealth Scientific Industrial Research Organisation), has 15 years experience in applying a single, coupled physical-sediment-biogeochemical model framework across these diverse estuarine and coastal systems. During the original development of the estuarine biogeochemical processes, bio-physical parameterisations were based where possible on plankton size and benthic plant geometry with the aim of increasing the portability of the model system across diverse estuarine types. Here we report on the subsequent implementation in 11 estuarine systems around Australia over the last 12 years. The range of parameter values used across estuarine types provides a metric of the transferability of the parameterisations, and suggests that it is top-down processes whose diversity is most difficult to capture in a single model. Bottom-up dynamics such as light and nutrient-limitation of primary production, while varied, are more easily captured in a single process-based model representation. Further development of the modelling systems aims to create a relocatable estuarine model that simulates circulation, sediment dynamics, water column optics, carbon chemistry and estuarine ecology. Progress to date includes considering the prescription of priors over biological parameters to capture uncertainty in model solutions and unconditional stable numerical schemes to ensure solutions in unexplored parameter space. The aim of the relocatable model is to provide

modelling capability for multiple geographical implementations and/or poorly-resourced studies, and as a starting point for more sophisticated dedicated studies of individual systems.

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UNTANGLING THE WEB: THE IMPORTANCE OF WETLAND PRODUCTION TO AQUATIC FOOD WEBS ACROSS THE FLORIDA ATLANTIC SALT MARSH-MANGROVE ECOTONE

As the climate warms, mangroves are moving pole-wards into wetlands previously dominated by salt marshes. In saline wetland ecotones across the southern USA this involves mangroves replacing *Spartina*-dominated marshes. While both wetland types are considered important habitats for a great diversity of nekton, mangrove production itself may play a much more minor role in aquatic food webs than does *Spartina* production. This study examined food web structure using stable isotope analysis of dominant producers and key functional groups of consumers common across sites spanning the Florida Atlantic wetland ecotone. The ecotone represents a natural experiment where the dominant wetland producer shifts from a C4 plant (*Spartina* $\delta^{13}C$: -12 to -14‰) to mangroves ($\delta^{13}C$: -26 to -30‰). Shifts in food web structure and the isotopic values of consumers across the ecotone provide insights into the true contributions of wetland production to aquatic food webs, and the likely effects on wetland-aquatic production transfers associated with the continuing expansion in mangrove range. Differences in the importance of mangrove and *Spartina* production to nekton have significant implications for the future value of these changing wetlands as nurseries that support species of ecological, cultural and economic importance.

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THE INFLUENCE OF SEA SURFACE VARIATION ON THE HYDRODYNAMICS AND SUSPENDED SEDIMENT DISTRIBUTION IN CROSS-SECTIONS OF TIDAL ESTUARIES

Field studies and numerical models have revealed that tidal and residual currents, as well as suspended sediment concentration, vary considerably inside and among cross-sections. Understanding the transverse distributions of flow and sediment is of considerable importance from both an ecological and economical point of view. To reach more physical understanding of these transverse distributions, several 2DV numerical and idealized models have been developed for both hydrodynamics and sediment trapping. None of these studies has analyzed the importance of free surface variations, even though scaling arguments and observations suggest that these variations cannot be neglected in, for example, shallow areas in estuarine cross-sections. Therefore, an idealized analytical model is developed to analyze and understand the sensitivity of transverse patterns of velocity and suspended sediment distributions to the free surface elevations. Estuaries considered here are characterized by strong mixing and relatively weak non-linearites; the density distribution, discharge and tidal prism are prescribed. An arbitrary-shaped estuarine cross-section can be imposed. The hydrodynamics is described by the 3D shallow water equations; sediment is only transported in suspension, and it is assumed that there is no tidally averaged suspended sediment transport. The system is analytically solved by use of perturbation methods. The incorporation of free surface elevation variations results in a better physical description of the cross-section hydrodynamics. As an example, we consider the cross—sectional dynamics in a transect of the Cheasepeake Bay (see Fugate and Friedrichs), where the lateral residual circulation can only be reproduced if the motion of the sea surface is accounted for. Hence, this improvement is important to better describe embayments where the variation in free surface elevation are important, such as the shallow areas in estuaries or shallow environments as lagoons.

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SEDIMENT AND VEGETATION MONITORING DURING A LEVEE REMOVAL PROJECT ON THE STILLAGUAMISH RIVER DELTA AT PORT SUSAN BAY, WA

Estuarine systems provide vital ecosystem services that would be difficult or impossible to provide by other means. In the Puget Sound, Washington, 80% of the original estuarine habitat has been replaced by human infrastructure, making the monitoring, preservation, and restoration of the remaining stock important both ecologically and economically. The objective of this project was to monitor the restoration of an estuarine system in the Stillaguamish estuary of the Puget Sound, WA that involved the removal of levees and the reintroduction of tidal flow into adjacent subsided farmland that was formerly part of the estuary, and to determine the sustainability of the Stillaguamish River delta and similar Puget Sound estuaries given rising sea-levels. The scope of this monitoring project included the installation and yearly sampling of sediment elevation tables (SETs), vegetation surveys and quantification of the net primary productivity (NPP) within the leveed area, immediately outside the levees, and within an un-leveed reference site across the main river channel. SET sampling, before the levee removal, revealed a positive trend in sediment accretion at 10 of the 12 SET sites of up to 1.4cm/year, well above current rates of ESLR. NPP averaged 1,124 DW(g)/m^2/year (September 2012). Vegetation consisted predominantly of Schoenoplectus americanus, Schoenoplectus acutus, and Schoenoplectus maritimus, with elevation and site location delineating the greatest shifts in community structure and abundance. The exception to this was within the portion of leveed farmland, where surface elevations were below the surrounding estuary and vegetation consisted primarily of a Schoenoplectus americanus monoculture.

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THE PROVENANCE OF BEACH SAND IN THE SAN FRANCISCO BAY COASTAL SYSTEM THROUGH THE CROSS-VALIDATION OF BED CHARACTERISTICS, GEOCHEMICAL TRACERS, CURRENT MEASUREMENTS, AND NUMERICAL MODELING

A unique, multi-faceted provenance study was performed to definitively establish the primary sources, sinks, and transport pathways of beach-sized sand in the San Francisco Bay Coastal System. This integrative program is based on comprehensive surficial sediment sampling of the San Francisco Bay Coastal System, including the seabed, bay floor, area beaches, adjacent rock units, and major drainages. Analyses of sample morphometrics and biological composition (e.g., foraminifera) were then integrated with a suite of tracers including 87Sr/86Sr and 143Nd/144Nd isotopes, rare earth elements, semi-quantitative X-ray diffraction mineralogy, and heavy minerals, and with process-based numerical modeling, in situ current measurements, and bedform asymmetry, to robustly determine the provenance of beach-sized sand in the region. Cross-validating geochemical analyses, numerical modeling, physical process measurements, and proxy-based techniques (e.g., bedform asymmetry, grain size morphometrics) is shown to be an effective technique for confidently defining sources, pathways, and sinks of sand in complex coastal-estuarine systems. The consensus results highlight the regional impact of a sharp reduction in the primary sediment source, the Sierras, to the San Francisco Bay Coastal System over the last century in driving erosion of the bay floor, ebb-tidal delta, and the outer coast south of the Golden Gate. Cross-validating geochemical analyses, numerical modeling, physical process measurements, and proxy-based techniques (e.g., bedform asymmetry, grain size morphometrics) is an effective approach for confidently defining sources, pathways and sinks of sand in complex coastal–estuarine systems.

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DEVELOPING ECOSYSTEM SERVICES-BASED ASSESSMENT ENDPOINTS FOR DETERMINING ECOLOGICAL RISKS TO COASTAL AND ESTUARINE ENVIRONMENTS

Current U.S. EPA ecological risk assessment (ERA) guidance defines an assessment endpoint (AE) as an explicit expression of the environmental value that is to be protected, and recommends that AEs are selected based on ecological relevance, susceptibility to known or potential stressors, and relevance to management goals. Assessment endpoints consist of the entity to be protected (e.g., harlequin ducks) and an important attribute (e.g., nesting habitat availability), and should reflect management goals and represent measureable ecosystem characteristics. Typical AEs used in the assessment of risks and impacts to estuarine areas include population and community-level entities with attributes of survival, abundance and production of plants, invertebrates and fishes. The U.S. EPA is extending existing AE guidance to ecological outputs that benefit humans and that are not

typically included in ERA, including production of food and drinking water, purification of air and water, pollination, and nutrient cycling. The supplemental guidance is organized according to seven categories of environmental values: consumptive, informational, functional/structural, recreational, educational, option, and existence values. The inclusion of ecosystem services-based AEs is intended to improve the value of ERA for environmental decision making. For example, the benefits of protection or remediation in coastal and estuarine systems can be cast in terms of the contributions to human well being through quantification of the changes in ecosystem services. Application of ecosystem services-based AEs in coastal and estuarine assessments can also provide an improved means of communicating risks because changes in the endpoints directly or indirectly benefit humans.

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VARIATION IN PH AT MULTIPLE SCALES AND ADDITION OF CONTINUOUS PCO2 MEASUREMENTS IN THE SOUTH SLOUGH ESTUARY, OREGON

Continuous physicochemical water measurements at four stations along the South Slough estuarine gradient, generated by the National Estuarine Research Reserve System-Wide Monitoring Program (NERR SWMP), indicate a shift toward higher estuarine pH over the period 2002-2009. This trend is unusual because it in the opposite direction from an expected decrease in pH, considering decreasing ocean pH associated with ocean acidification, and South Slough is in an upwelling influenced region, therefore, we may expect coupling between ocean and estuary water column conditions. pH has also increased in other western North America estuaries, although not consistently at all sites. One hypothesis that may be contributing to the estuarine pH shift is related to the Net Ecosystem Metabolism (NEM) rate of the system, which can be useful as an indicator of nutrient enrichment; therefore, understanding production of eelgrass, phytoplankton and/or benthic macroalgal assemblages in the South Slough may be important. Additional monitoring data at indicate a slight increase in eelgrass density and spatial cover; however, water column chlorophyll A concentrations were variable from 2004-2010. Synthesis of these results may help to explain the observed trend in pH in South Slough if NEM of the estuary is increasing. However, observed pH trends in estuaries are complex and influenced by many factors, including riverine/oceanic inputs, temperature, salinity, dissolved oxygen, photosynthesis/respiration, and nutrient concentrations. An instrument that measures the partial pressure of carbon dioxide (pCO2) deployed at one mid-estuary site and additional related carbonate chemistry measurements (e.g., Dissolved Inorganic Carbon, Total Alkalinity) will further advance understanding of the relationship between ocean acidification and pH in estuaries, and how these dynamics affect ecological and socioeconomic goods and services in regional estuaries and coastal-marine systems.

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MODELING THE SMALL RIVER PLUMES

While larger scale plumes have received significant attention, the dynamics of plumes associated with small rivers typical of California are little studied. Physical processes in these small plumes interact in ways that are different to larger plumes, e.g., flow rate varies on short time scales, and the coriolis term is typically unimportant. Since small streams are not dominated by a momentum flux, their plumes are more susceptible to conditions in the coastal ocean such as wind and waves. Due to limited data on physical processes at the requisite resolution, numerical modeling is used to better understand processes and phenomena including inertial jets, buoyant plumes, alongshore flow, mixing and surface stresses. Idealized model results for Santa Rosa Creek, California are presented from an implementation of the Regional Ocean Modeling System (ROMS v3.0), a three-dimensional, free-surface, terrain-following numerical model. In order to correctly model water transport at smaller scales, grids with varying resolution (5 - 80m) were constructed. In these preliminary results, the interaction between tides, winds, and buoyancy forcing in plume dynamics is explored for scenarios including different strengths of freshwater flow with different modes (steady and pulsed). Seasonal changes in transport dynamics and dispersion patterns are analyzed.

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THE EFFECTS OF ELEVATED CO_2 CONCENTRATIONS ON PREY CAPTURE, GROWTH AND MORTALITY IN LARVAL WHITE SEABASS (*ATRACTOSCION NOBILIS*)

Higher concentrations of CO_2 in ocean water increase concentrations of bicarbonate and H+ ions and cause ocean acidification (OA). Despite substantial research into the effects of OA on calcifying invertebrates, the effects on fishes remain largely unstudied. Because the larval stage is a critical period in fish development, understanding the effects of OA on larvae is important. OA can lead to decreases in the growth rate and metabolism of larval fishes and result in increased mortality. Thus, changes in larval development due to OA may contribute to potential shifts in abundance and fitness of fish populations. Decreases in both pH and the concentration of carbonate ions associated with OA affect biogenic calcium carbonate structures, including otoliths of larval white seabass (*Atractoscion nobilis*), which grew larger under experimental OA conditions. However, the consequences of these morphological changes on the biology of the fish themselves have not been well-studied. Little is known about the effects of OA on larval fish behavior and how changes in behavior may affect survivorship. The purpose of this experiment is to examine the effects of simulated OA conditions on prey capture and growth of larval white seabass. Larvae will be reared out to 18 days post hatch in three different CO_2 concentrations: Control – based on current concentration estimates (400 µatm CO_2), twice as high, and 2.5x higher, which may occur by the year 2100. Every few days, individual larvae will be observed and videotaped in petri dishes with *Artemia* nauplii to observe feeding behavior. Using the ImageJ program and a microbalance, a series of body measurements (length, width, weight) will be collected. These morphometric measurements will be used to calculate larval growth over time in the different CO_2 treatments. The results of this study will begin to clarify how OA affects larval fish feeding behavior, expanding from current knowledge of OA-related growth effects.

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ASSISTED COLONIZATION OF COASTAL COMMUNITIES: RESULTS OF A FUTURISTIC TRANSPLANT GARDEN EXPERIMENT

Migrating the leading edge of a species distribution in advance of climate change effects could be useful where dispersal is limited and rate of climate change is predicted to increase beyond the capacity of species to keep pace. Species occupying the seaward end of coastal gradients may be capable of establishing landward with the removal of biological filters. In August 2011, I initiated a reciprocal transplant experiment in which a series of 4 m2 plots (n=135) was established spanning coastal assemblages across the East River estuary in northwestern Florida. Vegetation was removed (treatment) or left undisturbed (control). Individuals of the dominant graminoids representing the gradient from salt marsh to upland pine savanna assemblages (*Spartina alterniflora*, *Juncus roemerianus*, *Cladium mariscus*, and *Aristida stricta*) were harvested. Each plot was subdivided into four 1m2 subplots, which were randomly assigned to a species. Ten individuals of the assigned species were planted into each of the subplots. All species successfully established in plots located in their source assemblages. In seaward plots, the upland grass *A. stricta* was the only species that did not survive, and the fresh marsh dominant *C. mariscus* had low survival, suggesting that abiotic stress limited these intolerant species. In all other parts of the gradient, the four species successfully established and were surviving. The most dramatic colonization result was that of *J. roemerianus*, the brackish marsh dominant, which survived in all freshwater wetland and upland habitats and appeared quite healthy. There were no differences between control vs. treatment plots, but in some cases initial survival was enhanced in control plots, possibly due to protection from herbivory. These results suggest that assisted colonization of downslope species into assemblages farther inland and upslope of their original source populations is feasible when biological filters are relaxed.

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HOURS, SEASONS, YEARS: TEMPORAL PH, CO2 AND O2 VARIABILITY IN A COASTAL MARSH HABITAT

The predicted anthropogenic increase in average open ocean pCO2 has motivated rapidly expanding research into CO2 sensitivities of marine organisms. However, most ecologically and economically important marine species inhabit coastal areas with higher and temporally much more variable pCO2 levels than in the open ocean. Here, we document the very high natural variability in pH, CO2 and O2 in a tidal marsh system that exemplifies spawning and nursery habitats of many marine and estuarine organisms. We analyzed five years (2008 – 2012) of continuous pH (NBS) and O2 data collected by a U.S. Geological Survey monitoring station (Flax Pond, Long Island, 40°58'N, 73°8'W) and complemented those with in situ pCO2 measurements over several 48h periods in 2012 and 2013. These data show a regular seasonal acidification pattern in this system: following high and relatively constant pH conditions in February (mean pH±SD = 8.19±0.04) increasing biological productivity triggers a substantial decrease in average pH with increasing short-term fluctuations from March to August (mean pH±SD = 7.59±0.07), before reverting back to initial conditions in early winter. During summer months (June-August), pH conditions regularly vary between 8.03 and 7.15, which corresponds to an order of magnitude in pCO2 fluctuations (~400 and >4,000 µatm) on hourly to tidal time scales. The most extreme pCO2 peaks (pH and O2 minima) coincide with the end of the night and low tide, whereas low tides during the day produce less extreme values. This suggests that metabolic processes and the degree of water exchange mainly drive the hourly to seasonal acidification patterns in this system, thereby exposing organisms regularly to levels twice those predicted for the year 2300 in the average open ocean. Seasonal acidification processes may be common in

productive coastal habitats and imply that organisms living, spawning and developing there exhibit adaptive mechanisms to cope with this variability.

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PLASTIC PELLET ABUNDANCE IN CALIFORNIA: DISTRIBUTION, SEASONALITY, AND TRANSPORT MECHANISMS

Plastic pellets are used to manufacture consumer products. As their production, use, and transport has increased over the last two decades, the quantity of plastic pellets entering the marine environment has also increased. Plastic pellets are a threat to marine organisms because of their small size (1-5mm) and ability to absorb persistent organic contaminants. Previous studies on the west coast of the United States found plastic pellets to be the most abundant type of marine debris on California state beaches. A 2009 statewide study indicated that there are four major geographic areas of concern within California: San Francisco Bay, Los Angeles, Orange and San Diego Counties. All four areas are distinguished as highly urbanized and high densities of inland plastic manufactures. In this study, we characterized the abundance, spatial distribution, and seasonality of plastic pellets on beaches within these four areas of concern. In addition, we tested the hypothesis that riverine runoff rather than loss during marine transport is the main mechanism for plastic pellet transport onto beaches. The results show that Los Angeles and Orange Counties have the highest abundance levels. Fifty seven percent of Los Angeles had plastic pellets on its beaches, whereas Orange County had 73 percent presence, indicating that the distribution of pellets is more wide spread in Orange County than in Los Angeles. In addition, we found no significant difference in pellet abundance between wet and dry seasons. Sites proximal to river mouths had a higher abundance then those distal to river mouths, indicating that riverine runoff is a main transport mechanism for plastic pellets. The results suggest that focusing management efforts on riverine sources can greatly reduce plastic pellet abundance in the marine environment.

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A MULTI-TIER APPROACH TO ASSESSING THE CONDITION OF SALT MARSHES OF THE BIG APPLE

Tidal salt marshes buffer coastal cities from the damaging effects of large storms and sea-level rise. In the past century, roughly 85% of coastal wetlands in the New York-New Jersey Harbor Estuary have been lost. Sea-level rise and urbanization may escalate losses, creating a particularly tenuous scenario given the increase in frequency of large super-storms such as Sandy which can cause large amounts of ecological and economic damage to coastal, urban areas. To date, no comprehensive conditions assessment or baseline size inventory of New York City's tidal salt marshes have been conducted. The New York City Department of Parks and Recreation Natural Resources Group in partnership with the Natural Areas Conservancy of New York City will take a multi-tier approach to assess the ecological health of each salt marsh complex in New York City to identify immediate conservation, management and restoration needs, preparing for the future effects of sea-level rise, eutrophication, and large hurricanes. Marsh vulnerability will be assessed on a landscape scale by analyzing land use, marsh fragmentation, and historic marsh loss using aerial photography and elevation compared to sea level rise inundation projections (Tier 1). A rapid assessment of each marsh will also be executed (Mid-Atlantic Tidal Wetland Rapid Assessment Method) (Tier 2) in order to put New York City's marshes in a frame of reference within the Mid-Atlantic region, and a systematic, marsh-wide, in-depth "snapshot" of vegetation community and soils (Tier 3) will be conducted across each marsh to develop a baseline condition and to statistically analyze for differences among salt marshes within New York's five boroughs. To examine long-term processes such as surface elevation change and accretion, vegetation community shift over time, and biomass production, six intensive monitoring sites will also be established (Tier 4).

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EGG QUALITY AND JUVENILE DEMOGRAPHICS OF *LIMULUS POLYPHEMUS* IN LONG ISLAND SOUND

Successful conservation and sustainable management of horseshoe crabs requires an understanding of life history traits and population demographics across age classes. While harvest restrictions may increase the number of eggs laid, it is the successful development of those eggs and juvenile recruitment into the adult population that ultimately results in population growth. Here we investigate two aspects of horseshoe crab reproduction and development. First, life history theory dictates that egg quality, the initial energetic investment in eggs by females, influences juvenile growth and survivorship. Egg quality is determined by maternal condition (e.g. energetic reserves, age) at the time of egg production. Poor maternal condition could result in the inferior provisioning of eggs resulting in delayed development or reduced survivorship. Female horseshoe crabs must provision eggs with enough yolk required for organ formation and embryogenesis. We investigated if egg quality (total lipids, caloric content) varies across females of varying conditions and habitats. Second, understanding and protecting the types of habitats that maximize juvenile horseshoe crab growth and survival is critical to long-term sustainable management of horseshoe crab populations. We investigated whether juvenile horseshoe crab growth rates and survivorship varies across habitat types in Long Island Sound. Preliminary data indicates at least 12 cohorts ranging from young-of-the-year (YOY) to 3 year-olds inhabit marshes adjacent to spawning beaches with dramatic declines between age classes that varied across sites. These results have implications for management with respect to targeting specific beaches and adjacent marshes for long-term protection. Restricting the harvest of adults in specific areas to increase egg production must also include consideration of quality of adjacent habitats where YOY will develop.

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ECOPHYSIOLOGICAL EFFECTS OF HYPOXIA ON ROCKFISHES INHABITING A COASTAL KELP FOREST OF MONTEREY BAY

Coastal areas of the California Current Large Marine Ecosystem (CCLME) routinely experience upwelling-related oxygen depletion with hypoxia reported in numerous regions, including the shallow rocky habitats within Monterey Bay. The Kelp Forest Array, a nearshore mooring in the southern part of Monterey Bay and adjacent to the Hopkins Marine Station, has provided real-time data illustrating hypoxic events occurring throughout the year with varying durations and levels of intensity. These hypoxic episodes have the potential to influence the structure, function, and flow of services to the coastal marine ecosystem and also stress, possibly lethally, resident fauna. A majority of nearshore taxa exhibit physiological responses at dissolved oxygen (DO) levels of ≤2-4 mg/L but specific thresholds for hypoxic stress, that vary with taxonomic group, life stage and exposure duration, are largely unknown. Our objective is to understand how low DO events within the CCLME affect the physiology of critical species residing within nearshore kelp forest habitats. We focus on juvenile rockfishes of the highly prolific Sebastes genus because of their importance to commercial and recreational fisheries, high abundance across shallow waters of the CCLME, and the potentially severe impacts of physiological stress on these species. To assess hypoxia thresholds and sensitivities of juvenile Sebastes exposed to low DO, we conducted a suite of experiments at different levels of biological organization, from whole-organismal to physiological/biochemical. Our data include measurements of critical DO limits (Pcrit), blood parameters (e.g. hematocrit) and activities of metabolic and oxidative stress enzymes. Results from our interdisciplinary study provide insights into the ecophysiological consequences of hypoxia for key fisheries species.

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POPULATION STATUS OF HORSESHOE CRABS ALONG THE EAST COAST OF INDIA- A CASE STUDY FROM ODISHA

Two sympatric species of horseshoe crabs, Tachypleus gigas and Carcinoscorpius rotundicauda have been mainly reported in literature from the Indian coastlines. The abundance and distribution patterns of T. gigas and C. rotundicauda were studied for one year (2009-2010) on fortnightly basis taking into consideration new moon and full moon phases across two sites in Odisha, located in the East Coast of India. Benthic fauna were also analyzed to gain an understanding about the availability of food resources to sustain

horseshoe crab populations, in addition to habitat quality assessment of the study sites. The highest number of horseshoe crabs was encountered in new moon phases and salinity strongly influenced the abundance of both the species from the study sites. Based on the benthic fauna analysis, it was clear that both the sites were relatively undisturbed and the abundance of benthic fauna, in particular meiofauna, played important roles in sustaining the horseshoe crab populations. This study highlights the necessity to protect and conserve horseshoe crab population and their habitats in South East Asia, which are gradually declining from increased anthropogenic disturbances.

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THE INFLUENCE OF FRESHWATER INFLOWS IN CALIFORNIA COASTAL LAGOONS

Bar-built estuaries along the Pacific Coast of the U.S. are dynamic systems, providing valuable marine, brackish, and freshwater habitat, with the amount and type of habitat depending heavily on the morphology of the inlet connecting the lagoon to the ocean. In California, the inlets of these systems often choke with sediment when energetic waves are present, disconnecting the lagoon from the ocean, but also providing important rearing habitat for salmonids. Although the inlet behavior is often tied to tide or wave characteristics, freshwater inputs also have a strong influence, particularly on the timing and duration of closure events. As a result of this influence, future changes in precipitation associated with ongoing climate change may alter the behavior of many California lagoons over time. To explore this, we examine the influence of freshwater inflows in detail using a combined hydrologic/morphodynamic model intended for small lagoon-inlet systems. The model is informed by observations at several small California lagoon sites, and is shown to reproduce the lagoon hydrodynamic response to a range of coastal and fluvial conditions. Lastly, we use the model along with available downscaled climate change predictions for precipitation to provide a discussion of the role of climate change on future hydrologic function of California lagoons.

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FROM GLITTERING *SALINAS* TO BARREN SALT FLATS: A ECO-GEOMORPHIC HISTORY OF TRANSFORMATION AND RESILIENCE IN THE COASTAL LAGOONS OF NORTHERN SAN DIEGO COUNTY, CALIFORNIA

Northern San Diego County supports a number of small river-mouth estuaries, considered an important coastal wetland resource for the Southern California region. Many of these systems are currently the focus of significant restoration and management efforts; however, fundamental questions about these systems' history and evolution have remained unresolved. To examine how these systems functioned in the past and how they have changed over time, we integrated hundreds of historical accounts to reconstruct ecological and hydrogeomorphic characteristics of six lagoons prior to major Euro-American modifications (ca. 1770-1880). Maps, texts, and photographs were collected from over 30 archives, assessed for accuracy and reliability, and synthesized into a GIS database. We documented a suite of regionally unique ecological characteristics, including expansive salt flats that composed the majority of estuarine area in some systems, substantial salt marsh with limited channel networks, and extensive freshwater-brackish transitional wetlands. Closure frequencies were highly dynamic and complex, varying across seasons, years, and systems. Despite their extremely dynamic setting, many features of these lagoons have been quite resistant to anthropogenic and climatic environmental perturbation, persisting across multiple decades and storm events. Recent decades have seen major transformations, including the near-total loss of salt flat area (less than 5% remains) and the conversion of former salt flat/marsh areas to brackish/freshwater marsh and large subtidal basins. Closure frequencies have also been substantially altered by direct (e.g., jetties) and indirect (e.g., dams) modifications. This understanding of the systems' historical context and trajectories provides a key perspective on current management issues, as well as insight into how to design resilient, climate-adaptive systems in the future.

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REDUCED BACTERIAL DIVERSITY AND ALTERED COMMUNITY COMPOSITION IN EXPANDING OXYGEN MINIMUM ZONES

Oceanic oxygen minimum zones (OMZs) play central roles in biogeochemical cycles and are expanding as a consequence of climate change, yet how deoxygenation will affect microbial communities that control these cycles is unclear. Through analysis of 408,013 16S rRNA sequences collected across the oceans' largest OMZ, we show that bacterial richness displayed a unimodal pattern with decreasing dissolved oxygen (DO), reaching maximum values on the edge of the OMZ, and decreasing within it. This pattern tracked DO profiles across stations, and some groups that were rare on the OMZ margin were abundant at lower DO—including sulfur-cycling Chromatiales, for which 16S rRNA was amplified from extracted RNA. Distribution models based on DO data suggest higher bacterial richness before deoxygenation, as well as strong relationships between DO and composition. Based on our results from the eastern tropical North Pacific, OMZ expansion and deoxygenation may constrict diverse regions of the water column and alter composition, competition, and function; all have implications for biogeochemical cycling in OMZs.

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SPATIO-TEMPORAL VARIABILITY IN MOVEMENT, AGE, AND GROWTH OF MOUNTAIN WHITEFISH (*PROSOPIUM WILLIAMSONI*) IN A RIVER NETWORK BASED UPON PIT TAGGING AND OTOLITH CHEMISTRY

Connectivity of river networks and the movements among habitats can be critical for the life history of many fish species, and understanding of the patterns of movement is central to managing populations, communities, and the landscapes they use. We combined passive integrated transponder tagging over four years and strontium isotopes in otoliths to demonstrate that 25% of the mountain whitefish (Prosopium williamsoni) sampled moved between the Methow and Columbia rivers, Washington, USA. Seasonal migrations downstream from the Methow River to the Columbia River to overwinter occurred in autumn and upstream movements in the spring. Our results suggest that migration is common during the first year of life, with migrants being larger than non-migrants. Growth between migrants and non-migrants was similar. Water temperature was positively related to the proportion of migrants and negatively related to the timing of migration, but neither was related to discharge. The broad spatio-temporal movements we observed suggest mountain whitefish, and likely other non-anadromous fish, require distant habitats and that management and conservation strategies to keep connectivity of large river networks are imperative.

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THE DELIVERY, SPECIATION AND FATE OF TRACE ELEMENTS IN A SHALLOW ESTUARINE SYSTEM, ST. LOUIS BAY, MISSISSIPPI, USA

St. Louis Bay, Mississippi, is a useful estuary for studying sediment-bound trace metal transport because it is shallow and prone to wind-driven resuspension. It is also disturbed by occasional and powerful tropical weather systems. During resuspension events, reduced bottom sediment along with pore water can be injected into the water column, providing metals which can then move under the influence of current or tide in dissolved or particulate phases. Repetition of this process could transport sedimentary and pore water metals out of the bay. It is hypothesized that during resuspension events, dissolved concentrations of Ni, V, Ba, and Cd will increase and result in them being flushed out of the bay, whereas Fe, Mn and Cr will be flushed out of the bay in particulate form. During January, 2011 (6 knots) and 2012 (15 knots), wind speeds were significantly different, but river discharge, salinity, and pH were comparable. While particle-reactive elements such as Fe, Mn and Cr showed decreased dissolved concentrations, Ba and V showed increased concentrations in January, 2012, as compared to January, 2011. Similar results were obtained during time series sampling (October, 2012) when sampling started during high wind speeds and ended during low wind speeds. Our initial results indicate that resuspension of bottom sediments can cause an increase in both particulate and dissolved metal concentrations.

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BENTHIC NITROGEN CYCLING AND THE FATE OF NITRATE IN WEEKS BAY, ALABAMA

Nitrate (NO_3^-) is the dominant form of nitrogen in the Weeks Bay National Estuarine Research Reserve (NERR) (Weeks Bay, Alabama, USA) because of inputs from urbanization and agriculture in the watershed. Microbially mediated processes can remove NO_3^- from the system via denitrification and/or anammox and thus mitigate nitrogen inputs. Alternatively, dissimilatory nitrate reduction to ammonium (DNRA) retains NO_3^- in the system as bioavailable ammonium (NH_4^+) but the efficiency of these three processes has not been investigated conclusively. Understanding which NO_3^- reduction pathway is prevalent is of utmost importance since either outcome has significant ecological implications. This

study investigated the seasonality of NO_3^- reduction pathways and benthic fluxes at two sites in the Weeks Bay NERR on a quarterly basis beginning in December 2010. Denitrification and anammox were measured by the isotope pairing technique and DNRA by a ^{15}N technique. Denitrification exhibited a seasonal pattern at the two sites in Weeks Bay, with the rates in June 2012 significantly higher (average: 41.0 ± 1.1 μmole N m^{-2} hr^{-1}) than the rates during the remainder of the study period (average: 12.5 ± 2.3 μmole N m^{-2} hr^{-1}). DNRA rates were similar to denitrification rates and DNRA accounted for 20 to 70% of the NH_4^+ efflux. Anammox accounted for 2 to 13% of the net N_2 flux. Strong evidence exists that benthic fluxes are temporally variable in this system and that DNRA may seasonally support water column productivity and episodic harmful algae blooms in the Weeks Bay NERR system.

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COMMUNITY COMPOSITION OF AMMONIA-OXIDIZING BACTERIA IN LOUISANA MARSHES IMPACTED BY THE DEEPWATER HORIZON OIL SPILL

Ammonia-oxidizing bacteria (AOB) carry out a critical step in the nitrogen cycle, yet impacts of acute oil exposure on AOB communities are unknown. We characterized AOB communities in salt marshes in Louisiana impacted by the 2010 Deepwater Horizon oil spill and compared them to AOB communities from nearby reference marshes. AOB community composition was assessed by DNA sequences and community fingerprints of the betaproteobacterial *amo*A gene. Sediment samples were collected in July and September 2012 from oiled and unoiled marshes in three regions (Terrebonne Bay and western and eastern regions of Barataria Bay). Additional samples were collected from Terrebonne Bay in May and August 2012. Within each region, we sampled 4 sites (2 oiled and 2 unoiled) at plots located 5, 10, 15, and 20 m from the marsh edge. Terminal Restriction Fragment Length Polymorphism (TRFLP) community fingerprints indicated no significant effects of oil or distance from marsh edge, but revealed significant effects of sampling date and region. Sequence analysis of *amo*A genes revealed that AOB communities in Terrebonne and eastern Barataria Bay sites were dominated by sequences similar to *Nitrosomonas aestuarii* and *N. marina*. AOB communities in western Barataria Bay were dominated by *Nitrosospira*-like sequences. Our results indicate that AOB communities in Louisiana marshes may be oil-resistant or have had sufficient time to recover since the initial exposure in 2010. It is also possible that chronic oil exposure in the Gulf of Mexico has already selected for oil-tolerant AOB, resulting in no detectable effects on AOB communities two years after acute oil exposure.

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NUTRIENT DYNAMICS BASED ON WHOLE-BASIN ECOSYSTEM METABOLISM FOLLOWING AN ANOXIC WATER VENTILATION

The Pettaquamscutt (Narrow River) Estuary is a 9km estuary in southern Rhode Island with two deep (13m and 18m) basins containing anoxic waters overlaid with 3-4m of well-oxygenated waters. In October 2007, a ventilation occurred in the northern basin and anoxic waters mixed throughout the water column. Such events are natural and occur when drought conditions, strong winds and a drop in temperature exacerbate the normal fall weakening of stratification. Daily profiles of water column parameters and weekly samples for phytoplankton and nutrients were taken from the day after the ventilation to early December. Phytoplankton were dominated by Prorocentrum minimum after the ventilation but after ten days several other species dominated. Ammonium concentrations were very high (150-400μM) soon after the ventilation but decreased (40-80μM) over the next 6 weeks. Nitrate plus nitrite concentrations were low in the upper water column (undetectable to 1μM) but increased slightly (3μM) over the next 6 weeks, while bottom water stayed at about 4μM. Phosphate concentrations were high (12-27μM) and then decreased (2μM). Calculations of rates were made for the basin as a whole. Rates of ammonium loss were within the range of literature values for phytoplankton uptake of ammonium in the adjacent Narragansett Bay. Rates of nitrate plus nitrate gain were similar to rates of nitrification in Narragansett Bay. As additional evidence for ammonium incorporation into phytoplankton biomass, rates of phytoplankton carbon fixation were also calculated based on these nitrogen values and Redfield stoichiometry, and the resulting chlorophyll was within the range of measured values. This study provides evidence that despite low oxygen values, phytoplankton and bacteria can take advantage of the nutrients made available by anoxic events in an ecosystem. This is an important consideration as anoxic areas potentially become more frequent and more widespread due to coastal ocean acidification.

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INFLUENCE OF ENVIRONMENTAL AND CLIMATIC VARIABLES ON EASTERN OYSTER POPULATIONS

Long-term fisheries independent oyster dredge surveys conducted in Texas bays from 1986-2008 were used to develop a spatiotemporal model of spat, juvenile, and adult Eastern oysters, Crassostrea virginica. Relationships between environmental predictors and oyster occurrence were investigated using boosted regression trees (BRT). Environmental conditions influenced abundance patterns for all size classes and results suggest oyster distribution and abundance are most closely linked to latitudinal variation in salinity regimes. In Texas, a natural climatic gradient exists where freshwater inflow decreases >50-fold moving south from the Louisiana to Mexico border, and estuarine inflows range from highly positive to negative (hypersaline). In light of future predicted changes in climate and reduced freshwater flows to the coast, these results provide practical information for managing C. virginica populations.

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INTERCALIBRATION OF CHLOROPHYLL AND PHYTOPLANKTON MEASUREMENTS TO NUTRIENT ENRICHMENT ACROSS NORTH EAST ATLANTIC. IS IT POSSIBLE?

Eleven European states have been involved in the Intercalibration of phytoplankton across the North East Atlantic (NEAGIG). This work rests on the premise that there is a common understanding of the Water Framework Directive's normative definitions in the context of nutrient enrichment, focusing on key principles relevant across European waters. For phytoplankton Intercalibration, those key principles are increases in chlorophyll biomass and excessive counts of single and total phytoplankton taxa counts. However, the The NEA GIG covers a very large geographic area from Southwest Spain (approx. 36N) to Northern Norway (approx. N). These areas will have different non-anthropogenic pressures, which would affect the ability of similar ecotypes to support phytoplankton, and consequently different thresholds need to be set. This talk sets out the setting of boundaries around common phytoplankton measurements, taking local geographical factors in account and describes the difficultly of translating qualitative descriptors, such as "increased biomass" into quantitative boundaries representing geographical and hydrological differences.

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SEDIMENTATION PATTERNS IN THE PROGRADING WAX LAKE DELTA, LA FROM 2008 TO 2011 AS A RESULT OF RIVER FLOODING, HURRICANES AND FRONTAL PASSAGE

It is imperative that we gain a better understanding of how prograding deltas build and evolve particularly in regions experiencing high rates of land loss, such as the Louisiana coast. Here we compare elevation change over 2008-2011 in the Wax Lake Delta (WLD), LA and the effect of spring river flooding, hurricanes, and winter frontal passage. WLD is an area of prograding deltaic wetlands building as a result of delivery of Mississippi River water and sediment via the Atchafalaya River and the Wax Lake Outlet. We surveyed the sediment surface elevation along seven 100 to 140 m long transects annually before and after spring floods and winter cold front passage and in 2008 before and after Hurricanes Gustav and Ike. We calculated change in elevation within each sampling plot and the mean net elevation change for each transect and across all seven transects. There was overall elevation gain of 7.4 ± 0.9 cm across all transects from 2008 to 2011. River flooding resulted in the greatest increase in elevation, particularly during the two largest flood years of 2008 and 2011, with 5.4 ± 0.9 cm and 4.9 ±1.2 cm respectively. The passage of Hurricanes Gustav and Ike in Sept. 2008 resulted in a net elevation increase of 1.2 ±0.4 cm, significantly lower than the two largest floods. Winter cold fronts resulted in net loss in elevation in all years except 2010 when the timing and pattern of river flooding was spread out from Oct. 2009 to Jun. 2010, with no distinct large spring peak. This overlap of river flooding and frontal passage resulted in zero net elevation change during both the periods of winter cold front passage and spring flooding in 2010, essentially cancelling each other out, despite the much higher total sediment discharge that year. The timing and duration of river flooding appears to have a very strong control on mineral sediment accretion, more so than the total annual sediment discharge and to a much greater degree than cold fronts and hurricane passage.

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STUDIES ON SEDIMENT DYNAMICS USING RADIOTRACER FOR MANAGEMENT OF DREDGING WORKS IN HOOGHLY ESTUARY, INDIA

Maintenance of the shipping channel leading to the dock is a prime concern of any port authority for movement of ships with adequate draft. This requires extensive maintenance dredging in shipping channel which is prohibitively expensive. For example, in Kolkata Port the shipping channel leading to Haldia Dock from the outer estuary requires maintenance dredging throughout the year. Six dredgers are deployed to maintain the navigable depth over the shallow stretches of the shipping channel leading to Haldia Dock. These dredgers use tidal windows to dredge over the shallow area, fill up their hoppers and then move to deep sea to dispose of the dredged materials. Apart from the cost involved in this dredging and transport, there is a critical issue about the effectiveness of this effort, as part of the disposed sediments may come back into the shipping channel. In order to implement the best management practice for dredging that will provide sufficient operational draft and minimize operational costs, it is necessary to study the sediment dynamics in this estuary so as to know the sediment dispersion pattern, which in turn will help in identifying the part of dredged materials coming back to the shipping channel. For this purpose radiotracer investigations were carried out near Sagar Island of West Bengal in 2007, 2010 and 2012. Scandium-46 glass powder having particle size ranging from 40-100 microns was used as a radiotracer. The tracer was injected at the seabed near the disposal ground using a remotely operated injection system and its movement was tracked using waterproof scintillation detector. From the tracer concentration curves iso-activity contours were plotted and parameters such as direction of movement on seabed, transport velocity, transport thickness and bed load movement rate were determined. Analysis of results indicated that the sediment predominantly moved towards north-east direction and a portion returned back into the shipping channel.

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DEVELOPMENT OF MULTI-SCALE, MULTI-STATE APPLICATION OF A PHYSICS-BASED DISTRIBUTED HYDROLOGIC MODEL IN THE CHESAPEAKE BAY WATERSHED

Quantifying the spatial variability in watershed responses is critical for improving our understanding of coupled environmental processes and effective management. Watershed models provide essential scientific information in the development of various large scale TMDLs, for e.g. Chesapeake Bay, but ironically, the management practices are implemented at local scales (in the order of hectares), creating a gap. Clearly, there is a pressing scientific and management need for the development of scalable, high-resolution, integrated simulation of regional watersheds and river flow that preserves the spatial variability of geo-spatial data in the model. Physics-based distributed environmental models can play an important role in bridging that gap. Fundamental challenges in achieving such implementation of distributed model include the significant amount of geospatial data processing and computation required in solving numerically stiff system of coupled environmental processes. In this paper development of a scalable, regional scale application of Penn State Integrated Hydrologic Modeling System (PIHM) is discussed that uses spatially explicit representation of parameters associated with topography, regolith, climate, land use/cover, soil and geology. The development of the scalable, large-scale model is demonstrated at Juniata River (drainage area 8800 sq. km.), a major tributary of Susquehanna River in Pennsylvania, with an average model grid resolution of 0.1 sq. km. (25.2 acres). Computational scalability in a high performance-computing environment was achieved by aggregating the model grids to Hydrologic Units. Model was calibrated at a small-scale (114 sq. km) sub-watershed using partition calibration strategy with Covariance Matrix Adaptation Evolutionary Strategy (CMAES). Model was validated using streamflow observations at 11 gage-stations across the watershed. Spatial variability in aggregates of water-budgets from 97 (12 digit) Hydrologic Units was analyzed.

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RISING SEAS AND FISH HABITAT

Relative sea-level rise coupled with other signals of climate change (altered hydrology, new salinity or nutrient regimes, shifting currents, and more) threaten to affect fish habitat. That possibility may be especially evident along our ocean and Great Lake coasts will habitats have fewer options to migrate as water rises. CERF, The Coastal Society, the American Fisheries Society, and others scientific and policy societies have an opportunity to join forces to make a difference. Those organizations, perhaps in partnership with coastal-dependent industry sectors, have the technical capability and historical access to provide leaders with information on how we address these imminent challenges. Scientific reviews, options papers, policy documents, educational programs, joint letters, and more offer us as professionals and society members the opportunitty to make a difference. In this era of reduced funding, such collaborations are logical and efficient. CERF 2013 could be hailed as a test bed for coastal and estuarine issues that demand attention. Joint efforts with The Coastal Society can add breadth to the effort. Working with the American Fisheries Society, the premier fish society for 143 years, can add unsurpassed credentials on fish of great recreational and commerical value. Together, perhaps with other groups focused on wetlands or coastal engineering or transportation, we can for relationships that could serve a models for agencies or industries. This talk will touch on such opportunities, with real examples of how our societies can stretch the envelope.

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OCEAN ACIDIFICATION ALTERS THE OTOLITHS OF A PAN-TROPICAL FISH SPECIES WITH IMPLICATIONS FOR SENSORY FUNCTION

Ocean acidification affects a wide diversity of marine organisms and is of particular concern for vulnerable larval stages critical to population replenishment and connectivity. While it is well known that ocean acidification will negatively affect a range of calcareous taxa, the study of fishes is more limited in both depth of understanding and diversity of study species. We utilized new three-dimensional micro-computed tomography to conduct in situ analysis of the impact of ocean acidification on otolith (ear stone) size and density of larval cobia (*Rachycentron canadum*), a large, economically important, pan-tropical fish species that shares many life history traits with a diversity of high-value, tropical fishes. We show that 2100 µatm pCO_2 ocean acidification significantly increases not only otolith size (up to 50% greater volume and 58% greater mass) but also otolith density (6% higher), with 800 µatm pCO_2 producing significantly greater mass (14%) and a similar but non-significant trend for otolith size. By using a modeling approach, we demonstrate that these changes could affect auditory sensitivity including a ~50% increase in hearing range at 2100 µatm pCO_2, which may alter the perception of auditory information by larval cobia in a high-CO_2 ocean. Our results indicate that ocean acidification has a graded effect on cobia otoliths, with the potential to substantially influence the dispersal, survival, and recruitment of a eurytopic fish species. These results have important implications for population maintenance/replenishment, connectivity, and conservation efforts for other valuable fish stocks that are already being deleteriously impacted by overfishing.

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PHYSICAL AND BIOLOGICAL REWORKING OF FLOOD EVENT BEDS AS EVIDENCED BY RADIOISOTOPIC PROFILES: A MODELING STUDY

Sediment transport models that represent flood and storm sedimentation for coastal areas typically estimate grain size patterns and deposit thicknesses and are therefore disconnected from field data that rely on radioisotope tracers to infer event bed character. For example, observations of an atmospherically derived radionuclide, 7Be, indicate terrestrial (riverine derived) sediment deposition offshore of a fluvial source. Conversely, 234Th naturally occurs in seawater through the decay of its generally conservative parent, 238U, and indicates the recent suspension of sediment in seawater. Interpreting field data based on radioisotopes presents challenges that stem from the tracers' source terms, as well as confounding sediment transport processes including suspended transport and physical and biological mixing. We use a numerical sediment model capable of estimating 7Be and 234Th profiles in the seabed to develop a quantitative tool to better reconcile model estimates with observational studies, and interpret field studies. The Community Sediment Transport Modeling System (CSTMS) implemented within the Regional Ocean Modeling System (ROMS) has been expanded to account for reactive tracers capable of representing radioisotopes. A one-dimensional (vertical) test case that includes three non-cohesive sediment classes and reactive tracers to represent 7Be and 234Th was subjected to realistic flood deposition and storm resuspension. Simulated profiles of 7Be and 234Th were directly related to the flood and storm sequences used as model input. The model showed that the radioisotopic profiles were sensitive to the timing of 7Be input, phasing of wave and current energy, and bioturbation rate. Post-depositional reworking of a flood deposit via resuspension modified the 7Be profile in a manner similar to bioturbation, but created a signature within the 234Th and grain size profiles.

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A REGIONAL APPROACH TO PREVENTING THE INVASION OF THE CHINESE MITTEN CRAB IN THE GULF OF MAINE

Rarely in the course of a marine infestation has it been possible to prevent a new species from becoming established or to control small, localized populations of non-native species. Unfortunately, we currently have the opportunity in the Northeastern United States with the Chinese mitten crab, *Eriocheir sinensis*. A native of Korea and China, the mitten crab was first identified on the eastern seaboard in the Chesapeake Bay and has since spread north to the Delaware and Hudson River systems. Given the potential threats to ecosystems, the economy and public health posed by the mitten crab, as well as the overwhelming difficulty and cost of eradicating nonnative species once established, we have convened a regional partnership focused on prevention and rapid response to prevent mitten crabs from becoming established in the Gulf of Maine. A collaboration of citizens, non-profit organizations, state agencies and professionals is engaged in an early detection network to prevent unintentional introductions and to document and remove live mitten crabs. Habitat data (e.g., watershed area, tidal intrusion, salinity intrusion, mean flushing days) were analyzed to focus citizen scientist monitoring efforts in areas most vulnerable to invasion. In concert with the Northeast Aquatic Nuisance Species Panel and state agency personnel, we are preparing a Northeast Rapid Response Plan to coordinate response to individuals detected by the network. By engaging diverse partners in a robust outreach program and establishing a coordinated response protocol for dealing with identified individuals, we seek to successfully prevent the establishment of this approaching invader.

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DEVELOPMENT OF A MACROALGAL ASSESSMENT FRAMEWORK TO DIAGNOSE SEAGRASS BED HEALTH

Seagrass beds worldwide are experiencing major declines due to harmful algal blooms associated with nutrient-rich runoff and recent evidence suggests macroalgae may play a key role. Therefore, it is important to document benchmarks in the response of seagrasses to bloom-forming macroalgae and how levels of adverse effect change as a function of type of macroalgae. We investigated the impact of varying abundances of two common macroalgal genera in California estuaries, Ulva spp. and Gracilariopsis spp., on the health of the eelgrass Zostera marina. We conducted a caging experiment in 1m2 plots of a Z. marina bed in Bodega Bay where we maintained five densities of Ulva (0, 1.0, 1.5, 2.0, 3.0, and 4.0kg/m2) and Gracilariopsis (0, 0.75, 1.0, 1.5, 1.75, and 2.0kg/m2) and uncaged controls over a 10 week summer growing season. Every two weeks algal samples were collected and Zostera growth, epiphyte load, and shoot density measured; the two algal species were also added or removed from plots to reset treatment levels. The abundance of Ulva in plots grew or remained consistent in each 2 week interval while there was a consistent decrease in Gracilariopsis. There was a negative relationship between Ulva abundance and Zostera shoot density with an approximately 50% decrease in shoot density over the course of 10 weeks in the three highest Ulva treatments. Ulva treatments > 2.0kg/m2 also experienced a three-fold decrease in epiphyte abundance and slower overall Zostera growth. There was no measurable effect of Gracilariopsis except for a trend of decreased epiphyte abundance at 1.75 and 2.0kg/m2. Thus, we found species-specific benchmarks, perhaps due to biomass persistence, direct negative effects on seagrass itself, and potential impacts on grazing food chains with loss of epiphytes.

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FRESHWATER INFLOWS AND BLUE CRABS: CAN TEXAS MEGALOPAE FIND AN ESTUARY DURING DROUGHT?

Freshwater inflows are crucial to maintain the function of estuaries, but can become limited due to human activities and climate change. The Mission-Aransas Estuary, Texas, experiences extreme year to year variation in freshwater inflows and salinity regimes, ranging from a normal estuarine gradient to a “reverse” estuary with hypersaline conditions. Previous studies have suggested that freshwater inflows affect populations of the commercially and ecologically important blue crab, Callinectes sapidus, especially in early life stages. There are two life history events when freshwater inflows may be the most important: (1) when megalopae (postlarvae) are recruiting into and moving up estuary via selective tidal stream transport and (2) when juveniles are seeking low salinity habitats (for lower predation or higher food abundance). Blue crab megalopae use increases in salinity as a cue to differentiate the flood and ebb tides, swimming up with an increase in salinity on the flood tide, which carries megalopae to favorable nursery habitats within the estuary. However, in drought years when the estuary becomes hypersaline, an increase in salinity occurs on the ebb tide, potentially transporting megalopae away from the estuary. We re-examined the role of salinity in flood tide transport of megalopae from the Mission-Aransas Estuary, and if this behavior could lead to year class failures of blue crabs. The behavioral role of estuarine chemical cues (e.g., terrestrial humic substances) in flood tide transport were also explored, and whether they interact with the effects of salinity to ensure flood tide transport during drought. Comparisons of experimental results to field data will explore whether there is a threshold freshwater inflow below which flood tide transport of blue crab megalopae fails.

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A STANDARDIZED FRAMEWORK TO ASSESS THE CONDITION AND STRESSES OF ESTUARY ECOSYSTEMS AT REGIONAL SCALES: A CASE STUDY OF THE NORTHERN GULF OF MEXICO

Estuaries are highly productive and critically important ecosystems that are prone to modification by human activities. In this study, we describe the development of a standard approach to (1) compare estuary condition relative to anthropogenic stressor gradients; and (2) identify key stressors and the scale at which they exert the most influence. Our approach uses the presence and abundance of fishes and invertebrates as indicators reflecting the condition of the local habitats where they live, feed, and reproduce. We demonstrate an approach whereby statistical models are used to systematically evaluate species sensitivities to stressors originating from the estuary shoreline, in the coastal watershed, or within the entire upstream river basin. Then we show how information about the species-level responses to stressors can be used to compare conditions between estuaries, and identify the influence and scale of stressors. Critically, we also identify stressor thresholds across which changes to species and ecosystems occur. We demonstrate our approach for 45 estuaries in the northern Gulf of Mexico, using a large trawl survey data set spanning 30 years. Specifically, we describe screening tools that were developed to rapidly assess 100s of possible species and community metrics to identify a subset that are most responsive to environmental stress and amenable to modeling. These candidate indicators were then used to model species and multi-species response to stress, and to map inter-estuary biological condition. This work is part of a national effort to assess the status of estuarine and coastal fish habitats throughout the United States in cooperation with the National Fish Habitat Partnership. We thus describe ways to scale-up the assessment to compare all estuaries in the country. Our approach yields results that offer important insights to decision makers at the regional and national level and is readily replicated in other places.

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NOVEL USE OF AN ACOUSTIC DOPPLER CURRENT PROFILER TO RECONSTRUCT LONG-TERM TIDAL PRISM MEASUREMENTS IN A SMALL SOUTHERN CALIFORNIAN TIDAL LAGOON

The San Dieguito Lagoon is the site of a restoration project required of Southern California Edison by the California Coastal Commission as partial mitigation for adverse impacts to the marine environment caused by the operation of the San Onofre Nuclear Generating Station (SONGS). The restoration project increased tidal prism, a critical element to the success of the project. Tidal prism was assessed in two ways: 1) indirectly during pre-restoration planning using a combination of wetland topography and measured tidal range and 2) directly during post-restoration monitoring using an Acoustic Doppler Current Profiler (ADCP) commonly used to measure stream discharge. Validation of predictions of tidal prism from the indirect method using the ADCP allows historical reconstruction of tidal prism in the wetland using long-term data on channel cross-sections, inlet channel configuration, river discharge, and ocean storm events. This information is of critical importance to evaluating and managing the restoration project and provides insight into similar-sized small tidal estuaries and lagoons typical of southern Californian coastal wetland ecosystems.

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RESPONSE OF *SPARTINA ALTERNIFLORA* TO CHEMICAL AND GRAZING STRESSORS IN AN EXPERIMENTAL SYSTEM

Coastal ecosystems such as saltmarshes are subject to many stressors both anthropogenic (oil spills, climate change) and natural (herbivory, predation), yet are critical to provision of important ecosystem functions and services such as sediment stabilization, storm buffering, fisheries production, and nutrient cycling. Saltmarshes in coastal Louisiana, dominated by the important foundation species Spartina alterniflora, are subject to large-scale stressors such as hurricanes and oil spills in addition to biotic stresses such as herbivory by snails, insects, and crabs. Understanding how S. alterniflora responds to these stressors is key to being able to predict resiliency and persistence of this habitat. We conducted a factorial mesocosm experiment to test the simultaneous effects of two chemical stressors, crude oil (South Louisiana surrogate) and dispersant (Corexit 9500A), and two groups of herbivores, the snail Littoraria irrorata and the insects Prokelisia marginata and P. dolus, on S. alterniflora growth, assimilation, and standing biomass. We found that chemical stressors generally had a negative effect on S. alterniflora, as expected. Treatments with oil generally had fewer new stems emerge, likely due to reduced ability of below-ground roots and rhizomes to support vegetative growth, and thus had lower overall growth. Oiled plants were also more stressed leading to fewer open photosynthesis reaction centers, as indicated by generally lower fluorescence values (Fv/Fm). Oiling also influenced grazers, which were less active in oiled treatments, leading to less grazing in these treatments. These results demonstrate the acute effects of oiling on S. alterniflora and closely associated grazers, and the need to more fully understand the role of oiling in reducing the resiliency of these saltmarsh systems.

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IS UREA A WATER QUALITY CONCERN IN THE SAN FRANCISCO ESTUARY?

Increasing anthropogenic sources of nitrogen as urea from fertilizer, animal feed, pesticides, and sewage have resulted in elevated urea concentrations in many estuarine and coastal environments. This has the potential to adversely affect coastal and estuarine environments. For example, elevated urea has been linked with increases in blooms of Harmful Algal Bloom (HAB) species. The San Francisco Estuary (SFE) is the largest estuary on the US west coast and is strongly influenced by agriculture and a large metropolitan area. However, little data is currently available regarding urea concentrations in the SFE or the potential ecological effects of increased urea to the estuary. Nearly one thousand discrete measurements of urea concentration, along with macro-nutrients and chlorophyll-a have been made throughout the northern SFE for the past six years. In contrast to other estuaries, urea is generally less than 1μM-N urea throughout the SFE, representing a small percentage of the nitrogen pool. Additionally, a preliminary set of urea uptake measurements (using 15N-labeled urea) suggest that both ammonium and nitrate are larger contributors to phytoplankton nitrogen uptake in the estuary. These results suggest a limited role for urea in phytoplankton – nutrient dynamics in the SFE.

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EMERGY VALUATION OF ECOSYSTEM SERVICES PROVIDED BY NATURAL AND RESTORED OYSTER REEFS

An emergy model of subtidal oyster reef habitat in Texas was developed to quantify ecosystem function and the provision of ecosystem services. Emergy is a measure of total energy necessary to produce a good or service, and thus can be thought of as 'energy memory.' Emergy evaluations can be used to represent environmental and economic values of a system in equivalent units, generally solar energy units. We have extended the emergy modelling framework to include flows through ecosystem services provided to humans. Solar emergy (solar emjoules, sej) values for nutrient regulation (via water filtration), food provision (i.e., oyster harvest), and recreational fishing opportunities were quantified for a natural oyster reef. Additionally, we applied our model to a restored oyster reef, and we present a preliminary comparison of function and provision of services between the natural and restored systems. To adequately represent the importance of oyster reefs to humans beyond typical market values, we must also include the numerous ecosystem services important for human well-being. By linking emergy analysis to ecosystem services, we can begin to quantify the total value of ecosystems. By comparing natural and restored systems via the emergy approach, we can better assess the success of restoration projects in terms of ecosystem function and the provision of ecosystem services.

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EXAMINATION OF *SPARTINA ALTERNIFLORA* ROOT CONTRIBUTIONS TO SALT MARSH SOIL VOLUME BY CT-IMAGING

The contribution of *Spartina alterniflora* roots-and-rhizomes (hereafter, roots) to soil volume was compared in two salt marshes representing the extremes of soil types along the Atlantic side of Virginia's Eastern Shore. Soil cores were collected in mineral and peaty marshes. The cores were scanned by computer-aided tomography and image processing was used to determine the volume of living, coarse roots. Live roots in the scanned cores were sorted from the soil, and root volume was measured as the volume of water they displaced. Coarse roots constituted 7.1% and 5% of the soil volume (peaty and mineral soil, respectively) by the displacement approach. Significant regression relationships were found between CT-determined volumes and displacement-determined volumes. The peaty soil relationship was nearly 1:1, while the CT-determined volumes for the mineral soil were 2-3 times lower than the displacement-determined volumes. CT-imaging previously has been used to accurately and rapidly quantify coarse root mass in coastal wetlands. Our results show that CT imaging may also be used to quantify coarse root volume in salt marsh soils and that in peaty soils, coarse roots make an important contribution to soil volume.

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A SAMPLE FILTRATION METHOD FOR CARBONATE CHEMISTRY ANALYSIS OF COASTAL AND ESTUARINE SEAWATER

Carbonate chemistry measurements in biologically productive coastal oceans and estuarine environments can be complicated by high biomass and heavy sediment loads, which may interfere with the analyses. Consequently, a method is needed to filter samples from these environments, which does not alter the dissolved gas content, and consequently does not affect the dissolved inorganic carbon (DIC) and pH of the sample. Here, a filtration method is presented in which the sample seawater is pumped using a peristaltic pump through a 50 mm polycarbonate filter holder with a disposable 0.45 μm filter and then into the sample bottle. Replicate sets of samples, filtered and unfiltered, were taken from seawater that did not contain large particulates to assure that the filtration method did not alter the dissolved carbon content, which would compromise the subsequent sample analysis and data usefulness. Seawater with particulates added was then tested to prove that the method could successfully filter out particles, and produce dependable results. This work will help to ensure more consistent and reliable measurements in coastal estuarine environments by providing a standardized method for sample filtration.

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UNDERGRADUATE RESEARCH: OPENING DOORS AND WINDOWS

Hands-on research provides an excellent tool for teaching undergraduates. It trains students to: a) think critically and analytically, b) communicate effectively, c) acquire and analyze information, and d) apply these skills to problem solving. For the past 15 years the University of South Alabama's Undergraduate Research Program (UCUR) has been providing students with hands-on training in their discipline, expanding their experience beyond that of the normal classroom. To date more than 550 students have participated in our campus-based programs. Our mission is to expose undergraduates from all disciplines to basic research, creative, and scholarly activities through one-on-one interaction with faculty. The program encourages cross-disciplinary study, increasing interactions among faculty across campus. The UCUR program is unique in that it provides students with the opportunity to interact with students from a wide array of fields through informal discussion sessions. Participants learn to describe the importance of their research to a diverse audience and are given unique outlooks on their topics. Students also participate in professional development workshops, and each fall we celebrate their accomplishments at our Undergraduate Symposium. Undergraduate research experiences prepare students for the transition from undergraduate studies to the workforce or graduate school as to quote a student, "the benefits and knowledge that it offers combine the theoretical material that we learn in classes with the practical experience that we can gain at a job. Research puts these two methods of learning into one package."

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CASE STUDIES IN SEA LEVEL RISE PLANNING: PUBLIC ACCESS IN THE NY-NJ HARBOR ESTUARY

Public access to coastal resources faces significant pressure in the New York-New Jersey Harbor Estuary, the most urban estuary in the nation, and access is likely to decrease with sea level rise. While there are many valuable large-scale sea level rise (SLR) planning efforts in existence, few plans provide recommendations for sea level rise adaptation at the site-scale. In response to this issue, the NY-NJ Harbor & Estuary Program partnered with Great Ecology to launch Case Studies in Sea Level Rise Planning: Public Access in the NY-NJ Harbor Estuary. The project used GIS to model the SLR vulnerability of publicly accessible waterfront infrastructure and natural resources at three sites on the Raritan River in New Jersey. The model combined LiDAR data, publicly-available GIS data, and information gathered during site assessments to create a geospatial composite overlay and a Coastal Vulnerability Index (CVI) model (adapted from Tallis et al. 2011). The CVI model considered six main criteria: geomorphology, relief, low-lying areas, natural habitats, soil type, and projected sea level rise. Great Ecology and the NY-NJ Harbor Estuary Program then presented the results along with site-specific SLR adaptation recommendations to municipal and county planning agencies. By including recommendations at the site-scale, the case studies provided practical insight into ways to minimize potential ecological and public access infrastructure damages. The CVI model demonstrates a rapid method that can be easily implemented to provide coastal communities with the information needed to plan for SLR. As we consider future sea levels and post-Sandy planning for a resilient future in the NY-NJ region, this kind of site-scale approach, paired with larger-scale planning, becomes increasingly important to promote public access to coastal areas in our region.

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RECENT ENVIRONMENTAL RECORDS OF GLOBAL CHANGE: EVALUATION OF SEA-LEVEL CHANGE RATES BY USING 210PB-DATED SEDIMENTARY RECORDS IN VERACRUZ, MEXICO

Recent observations of sea level change are consistent with global warming. It has been shown that since 1993 the sea level rises at a mean rate of 3.1 mm y-1. Because the increase is not uniform globally, it is important to have reliable information on this change to corroborate the predictions of climate projections locally. In Mexico, there is a scarcity of information and availability of long-term instrumental (tidal-gauge) records. Therefore, this study proposes to determine the rates of sea level rise during the last 100 yr by the study of sedimentary records of two coastal lagoons in Veracruz, Gulf of Mexico using the 210Pb sediment dating method. This is based on the hypothesis that accretion rates in coastal environments such mangrove saltmarshes are similar to the change in sea level. Elemental composition will be used to corroborate the landward marine incursion in these ecosystems. In this work we will present the preliminary results of mangrove saltmarsh accretion in Veracruz and will compare these with instrumental records (tidal gauge and altimetry).

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NUMERICAL SIMULATIONS OF FLOW AND WATER QUALITY FOR THE ANALYSIS OF MANAGEMENT ALTERNATIVES AT THE RUSSIAN RIVER, CALIFORNIA

There is a growing acceptance of outcomes of numerical simulations as useful tools to interpret, analyze and predict the flow in bar-built estuaries, with the objective of managing them. Implemented numerical models can be used to explore diverse management scenarios in order to fulfill multi-purpose objective functions, to analyze hypothetical flow conditions, and to address simplifications of complicated scenarios. The Russian River estuary (RRE) characterizes by the closure of its mouth several times each summer, due to sediment deposition at the river mouth driven by waves when the discharging river flow rate is relatively low. During closure conditions, the circulation at the RRE changes dramatically, resembling the behavior of a lake: The exchange of salt with the ocean stops, and water of high salt content becomes trapped below a thin (approximately 1-m) fresh water surface layer, generating stratification. Wind is responsible for internal waves within the estuary with semi-diurnal periods. The strong stratification also precludes the transport of dissolved oxygen (DO) from the surface of the estuary to the deep waters in the estuary – river pools. Because of bio-chemical processes in the water column, DO concentrations reduce near the river bed resulting in severe environmental problems. Aimed at comparing potential solutions for this complicated environmental conditions, two-dimensional simulations of the RRE with a commercial code have been developed. We simulated the flow in the RRE subjected to diverse river discharge and wind forcings, as well as addressed different management conditions for the river mouth. Model results show a good quantitative agreement with density contours obtained from our own field observations, and an overall adequate prediction of the dynamics of the RRE in terms of internal waves, thickness of the fresh-water layer, and response times.

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DIFFERENCES IN DENSITY, ALLOMETRY, AND GROWTH BETWEEN TWO POPULATIONS OF *LIMNOPERNA FORTUNEI* (MYTILIDAE) FROM THE RíO DE LA PLATA BASIN, ARGENTINA

The invasive freshwater golden mussel, Limnoperna fortunei (Dunker, 1857), has a great capacity for colonizing a wide range of aquatic environments because of its dispersal ability, high fecundity, and wide range of physiological tolerances. Most of the biological and ecological studies of L. fortunei have been restricted to specific locations, so there is a lack of comparative analyses among different habitats. In this investigation, we examined the differences in larval and settlement plate densities, shell allometry, and growth between two populations from the Río de la Plata basin. One of the populations inhabited a heavily polluted area, whereas the other a moderately polluted area. We predicted that the density and growth of the golden mussel would be lower in the heavily polluted environment. We also expect to find variations in shell allometry as a consequence of differences in density and environmental conditions between the sites investigated. We accordingly found that the larval density, the density of settled individuals and the growth were lower in the more polluted environment. We also observed allometric differences between populations with the organisms from the less polluted area having more elongated shells. The golden mussel tolerates a wide range of environmental conditions and can survive in many polluted water bodies where other invasive species cannot. The findings presented here supports the idea that L. fortunei can inhabit heavily polluted environments, but at the expense of a significant decrease in its biological potential.

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IDENTIFYING FRESHWATER INFLOW AS A DRIVER OF ESTUARINE PHYTOPLANKTON STRUCTURE

We investigated the role of freshwater inflows as a mechanism that fuels primary production in a model estuarine system (Galveston Bay, Texas). Multivariate community analyses allowed us to map temporal and spatial differences in the phytoplankton structure and correlate dissimilarity to hydrographic and chemical data collected during a range of inflow conditions between 2008 and 2009. Our results indicate that overall phytoplankton biomass and community composition were highly regulated by temperature and variables related to freshwater inflows such as gauged discharge and inorganic nitrogen and phosphorus concentrations. Specifically, we show that diatoms dominated during periods of moderate to high inflow (3000-8000 cfs-1) during winter/spring and at stations closest to marine water originating from the Gulf of Mexico. Furthermore, cyanobacteria were dominant during summer/fall months when freshwater discharge was decreased (<3000 cfs-1) and were also more abundant in areas closest to riverine sources. Our data highlight the importance of seasonal freshwater inflows as a driver of phytoplankton structure in Galveston Bay. Understanding the dynamic interactions between freshwater inflows and phytoplankton communities in estuaries is important as they serve as the base of the food web for economically and ecologically important consumer organisms and their larvae. This should be considered by water regulators in urban areas because climate change and increased urbanization may alter the magnitude and timing of inflow events. In addition, future

work regarding primary production in estuaries elsewhere should take into consideration freshwater inflows as a mechanism that alters the phytoplankton community therein.

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INTERCONNECTIVITY OF SAV HABITAT IN CHESAPEAKE BAY: APPLICATION OF A PARTICLE-TRACKING MODEL TO PREDICT THE DISPERSAL OF *ZOSTERA* REPRODUCTIVE SHOOTS

Past studies of submerged aquatic vegetation (SAV) have focused mostly on small-scale population dynamics, such as the growth of a particular bed or beds within a given sub-region. This is in large part due to the assumption that long distance dispersal of SAV seeds must be a rare event, therefore small scales are more appropriate. However, recent research has demonstrated that long distance dispersal of SAV propagules may play a pivotal role in enhancing population survival. It has been demonstrated that seagrass seed recruitment plays a key role in patch development, and may play a role in developing higher than predicted levels of genetic diversity within populations. In this study we apply a coupled particle-tracking and hydrodynamic model, forced with observed winds and freshwater flow, to predict the range of dispersal of floating reproductive shoots of the seagrass Zostera marina in the Chesapeake Bay (USA). Initial simulations suggest that a high potential for cross-bay transport exists. Further studies will verify model predictions using genetic analysis.

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PATTERNS OF DECLINING OXYGEN CONTENT ALONG THE SOUTHERN CALIFORNIA COAST

Declining dissolved oxygen (DO) concentrations have been documented for California Current oceanic waters, but patterns on the continental shelf are less clear. Here we examine a 50+ year data set from a regionally-coordinated southern California water quality monitoring program to assess temporal trends and determine whether nearshore waters are exhibiting changes in DO content similar to those reported offshore. We found that DO in subthermocline nearshore waters (< 10 km from shore) have declined four times faster than reported for offshore waters over the last 15 years. These trends were evident over multiple depths and along isopycnals and have no precedent over the past 50 years. Large-scale climate variability in ocean DO associated with the Pacific Decadal Oscillation accounts for only ~30% of the observed decline in nearshore waters. Coastal biophysical processes are likely contributing to the recent elevated rate of DO decline in nearshore waters, as evidenced by higher rates of increase in the apparent oxygen utilization. It is unclear whether these processes result from upwelling-derived or anthropogenic nutrient inputs, but our findings point towards a need for continued observation and modeling to quantify the effect of anthropogenic nutrients on dissolved oxygen content in nearshore waters, and to improve strategies aimed at adaptively managing marine resources in light of these current trends.

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ASSESSING THE PREVALENCE OF HYPOXIA VIA MO ACCUMULATION IN COASTAL SEDIMENTS: THE INFLUENCE OF N LOADING AND LOCAL RESIDENCE TIME

One approach to developing nitrogen (N) criteria for coastal waters is to determine quantitative relationships between N loading and ecological effects such as hypoxia. Hypoxia may vary significantly within estuaries, making it difficult to document over large spatial and temporal scales. Accumulation of molybdenum (Mo) in surface sediments has been proposed as an indicator of the duration of hypoxia in overlying waters, providing a metric to evaluate the relationship between varying N loads and the occurrence and duration of hypoxic conditions in more than a dozen southeastern New England (USA) estuaries. Nitrogen loads were calculated for each estuary based on watershed land use. Because effects of nitrogen are expected to vary with residence time of the nitrogen within estuaries, N loads were normalized in each estuary for volume and local residence times (LRT) derived from hydrodynamic modeling to account for tidal flushing. Multiple sampling sites were selected within each estuary to span a range of normalized N loading, and surface sediments collected at each site for Mo analysis. A linear relationship between the concentration of Mo in surface sediments and the annual duration of hypoxia (defined as dissolved oxygen concentrations below 2.8 mg/L) was derived for southeastern New England estuaries and used to convert Mo concentrations to average annual duration of hypoxia. This presentation will illustrate the spatial distribution of hypoxia derived from the Mo data and the quantitative relationships between N load, residence time and extent/frequency of hypoxia. By combining these relationships with knowledge of hypoxia tolerance in local or critical species, this approach may be useful to evaluate criteria for nitrogen loading in coastal waters.

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OPPORTUNITIES AND CHALLENGES FOR POLICY MAKERS, MANAGERS, AND SCIENTISTS IN PLANNING FOR AND IMPLEMENTING MARINE SPATIAL PLANNING

In response to the many existing and emerging demands on coastal and ocean resources, President Obama established by Executive Order the National Ocean Policy (NOP) in 2010, identifying Marine Spatial Planning (MSP) as a mechanism to reduce conflicts and improve management. MSP is a comprehensive and integrated concept, and successful implementation requires collaboration of scientists, policy makers, and managers at state, tribal, and regional levels. Collaboration provides opportunities for improved integration, but also poses challenges as agencies and other involved parties identify effective means for engaging partners and stakeholders in this marine planning effort. On the west coast, the National Oceanic and Atmospheric Administration (NOAA) was designated as a federal co-lead for implementation. NOAA's Western Regional Collaboration Team (NOAA West), a cross-cutting line office team, recognized the need to evaluate the agency's diverse science, policy, and management work force prior to reaching out to partners and stakeholders. The west coast Sea Grant programs and NOAA West initiated assessment of NOAA's knowledge, capacity, and needs related to MSP through focus groups and a web-based survey. Through nine focus group meetings held in California, Oregon, and Washington, 90 NOAA employees and affiliates discussed key elements of successful stakeholder engagement, and voiced challenges posed by MSP. The subsequent Web-based survey more broadly evaluated the west coast NOAA work force (n=238) and provided insights into their knowledge of and involvement in MSP; existing and preferred methods for receiving information; and gaps and challenges associated with stakeholder engagement, data sharing, and tools. Research results inform NOAA on more effective internal communication of agency messages, improved partner and stakeholder engagement in MSP, and planned state and regional level implementation of this multi-disciplinary national initiative.

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TIDAL MARSHES IN THE LOWER COLUMBIA RIVER AND ESTUARY: HISTORICAL PERSPECTIVE, PRESENT CONDITION, AND FUTURE OUTLOOK

Wetlands in estuarine and tidal freshwater reaches of the Columbia River are controlled by variable hydrology of a highly-managed river. Development in the past 130 years has resulted in a reduction in floodplain wetlands, however, a reduction in river flows over this period has also resulted in an increase in wetland area from progradation of some remaining wetlands. In our study of 25 emergent tidal marshes to determine historical extent, 21 were present on historical maps from the late 1800's, and 10 had increased in area at least 28% percent. An analysis of water levels representative of the hydrologic regime of the past 20-30 years indicates that the average wetland elevation is similar to the average water surface elevation at the sites. We hypothesize that these marshes have responded to the change in water levels in recent history and that in earlier years when water levels were higher, marsh elevations were likely higher as well. To date, these wetlands have been able to migrate in response to the reduced flow regime; however, the future hydrologic regime is likely to be altered further from a combination of sea level rise, climate-driven hydrologic variation, and changes in water management practices. The expected result of these changes in the

estuary is uncertain, but a possible outcome could be a lower magnitude spring freshet, and a prolonged run-off period. Our analysis of the effects of hydrologic variability on these wetlands indicates that this condition could result in an overall increase in inundation that could lead to a spatial shift of emergent wetland species. Upward migration, necessary for these wetlands to maintain the required hydrology, is often limited by topography and man-made barriers. While more research is needed to evaluate the effects of future scenarios, these preliminary results indicate a need to focus restoration efforts on higher elevations with buffer zones that would allow for upward migration of existing marshes.

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FROM THE OFFICE TO THE OCEAN: PARTNERING WITH CORPORATE EMPLOYEES TO COLLECT WATER QUALITY DATA GLOBALLY FOR WATER QUALITY RESEARCH AND MANAGEMENT

Aquatic ecosystems in coastal urban environments have been significantly compromised as a direct result of modified land cover and infringement on buffer areas and as an indirect result of changes in consumption patterns and population density. Globally, urban growth will add 1.5 billion people by 2030, increasing the need both for integrated management approaches and to engage new audiences to address issues of water quantity, quality and aquatic ecosystem services. In the present global research program, we have partnered directly with a corporate sponsor to train and direct over 7000 corporate employees to become Citizen Science Leaders in major coastal cities in Europe, Asia-Pacific and the Americas. Participants follow a globally consistent training program and monitoring methodology to support research by local scientists. They perform regular monitoring of hydrological, ecological and chemical parameters in local ecosystems. The curriculum of the training day informs the participants on regional and global water quality and quantity issues to both encourage them to collect data for the research program and make changes in their lives and communities to improve water quality. Participants are also taught effective communication skills to further empower action within their sphere of influence and provided with online tools for educating themselves and others using social media, game theory and other collaborative online tools. Local and global data control mechanisms insure a consistent global database that will allow an international team of scientists to explore controlling factors of freshwater ecosystem dynamics in urban environments. Our intention is for these datasets, collected by corporate employees and their wider communities will inform policymakers' water resource management plans both locally and globally. A broader focus on outreach, outside of the usual audiences, is needed to ensure the sustainable use of one of world's most valuable resources.

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INCREASING NUTRIENTS, CHANGES IN ALGAL BIOMASS, AND LARGE *NOCTILUCA* BLOOMS IN PUGET SOUND: IS EUTROPHICATION FUELING THE MICROBIAL FOOD WEB?

Because of its proximity to the cold, nutrient rich Pacific Ocean, Puget Sound is thought of as a diatom-dominated marine food web supporting higher trophic levels via a relatively short food chain. Phytoplankton species respond to nutrient availability, nutrient composition, and the physical character of the water column. Through our long-term monitoring program and aerial surveys we have found that nutrient concentrations in Puget Sound have significantly increased and nutrient ratios have steadily changed over the last 13 years. We also frequently document extensive algal blooms, Noctiluca blooms, and jellyfish masses at the surface. Depth integrated algal biomass, on the other hand, shows a significant steady decline from 1999 to 2012. These seemingly opposing observations - high algal biomass and Noctiluca at the surface and decreasing integrated phytoplankton biomass below the surface - could be more clues to a shifting food web structure and nutrient fluxes in Puget Sound. The cause and impacts of these trends are discussed in the context of human pressures, climatic and oceanic boundary conditions, and planktonic food web structure.

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ENVIRONMENTAL CONTROLS OF POLYCHAETE COMMUNITIES IN A EUTROPHIC MESOHALINE ESTUARINE SYSTEM: VARIATION WITH DEPTH

An increase in hypoxia (dissolved oxygen (DO) < 2 mg/l) is an environmental stressor associated with eutrophic environments that can shift benthic community structures towards opportunistic macrofauna. Chesapeake Bay is a eutrophic estuary where seasonal hypoxia has been increasing since the early 1950's. Utilizing the large dataset of benthic macrofaunal abundance, collected by the Chesapeake Bay Benthic Monitoring Program, in conjunction with concurrent measures of environmental parameters (e.g., depth, sediment type, salinity, temperature, DO), this study examines how environmental conditions regulate the densities of opportunistic polychaetes in a mesohaline estuarine system. The analysis of polychaete abundance and biomass in the mesohaline Chesapeake Bay region points to a benthic community dominated by euryhaline, opportunistic polychaete worms (*M. viridis, S. benedicti, H. filiformis, A. succinea*). Macrofauna samples were divided into three groups by depth ranges that often have similar sediment types but also have similar overlying water properties, including dissolved oxygen concentrations. Linkages between variations in environmental factors and abundance and size of animals were initially evaluated using Spearman rank correlation and linear regression analyses. Regression tree CART analysis was used to examine in more detail what environmental factors exert the greatest influence on patterns of polychaete abundance during different seasonal time periods. This study supports previous work indicating a shift in the dominant polychaete community of the mesohaline Chesapeake Bay to one made up of four species known to be extremely adaptable to stressful conditions like hypoxia. Our analysis further shows that the magnitude of these polychaetes response to hypoxia is species specific and dissolved oxygen the "master variable" controlling long term trends in this polychaete community.

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IDENTIFICATION OF THALASSINIDEAN SHRIMP FOOD SOURCES IN AN OREGON ESTUARY USING FATTY ACID ANALYSIS AND STABLE ISOTOPE RATIOS (C,N,S)

Two species of burrowing shrimps occur in high densities in U.S. West Coast estuaries, the ghost shrimp (Neotrypaea californiensis) and the blue mud shrimp (Upogebia pugettensis). Both species create deep burrows in intertidal sediments and are considered ecosystem engineers because they turn over sediment and influence benthic communities. Together these two species of shrimp make up one of the dominant habitat types in the Yaquina Bay estuary on the central Oregon coast, yet little is known about what they feed on and how they fit into the estuarine food web. The primary goals of this study are to identify the major components of burrowing shrimp diets and detect variation in shrimp diets along an estuarine gradient using a combination of fatty acid (FA) and stable isotope (SI) analyses. A total of 137 shrimp were sampled from several locations within the Yaquina Bay estuary in August 2012. An additional 178 samples of the various potential food sources for these shrimp were also taken along an estuarine gradient. Potential diet items included eelgrass blades, epiphytes, Ulva, sediment surface, sediment core, burrow wall and plankton. Preliminary results from FA analysis indicated a strong difference in food ingested by shrimp along the estuarine gradient. Shrimp near the estuary mouth had high levels of 16:1ω7 suggesting a diet high in algae and marine diatoms. Shrimp from upriver showed greater amounts of FA associated with dinoflagellates and terrestrial run off. Bacterial FA signatures were less than expected for deposit feeding organisms. This is the first study to evaluate diets of these two species of burrowing shrimp using the combined approach of FA and SI analysis.

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ADAPTIVE MANAGEMENT FOR POPULATION RESILIENCE IN MARINE PROTECTED AREAS

Marine protected areas (MPAs) are being implemented and managed adaptively in California and worldwide. The usual expectation is that MPAs will lead to increases in the abundance and age and size of fished species. Consequently adaptive management typically focuses on monitoring and analysis of changes to population abundance and size or age structure after MPA implementation. However, one of the proposed practical benefits of MPAs is increased capacity to absorb both episodic shocks such as hypoxic events, and chronic shifts such as climate change and ocean acidification. Monitoring to detect changes in abundance and size structure may be missing evidence for these important benefits. Here we use our models of population responses to MPAs to describe the relationship between changes in abundance and age structure due to MPAs, and the increase in population resilience due to MPAs. Review of proposed increases in resilience by MPAs and evidence of actual increases indicate that increased buffering capacity by MPAs can be cast in terms of increased persistence and decreased variability. Indicators of these metrics are presented graphically so that managers can easily use them to allocate monitoring resources.

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EMERGING ISSUES IN HORSESHOE CRAB CONSERVATION: A PERSPECTIVE FROM THE IUCN SPECIES SPECIALIST GROUP

The four living species of horseshoe crabs (HSC's) are distributed along the east coast of North America from Maine to the Yucatan Peninsula, and in Southeast Asia from Japan to the Bay of Bengal. At the recent International Workshop in Hong Kong, there was consensus that HSC populations throughout Southeast Asia are in decline. The HSC Specialist Group within the International Union for the Conservation of Nature (IUCN), established in 2012, is working to update the Red List status of the three Asian HSC species (presently categorized as "data deficient") as a necessary first step in advocating for greater protection. The depletion of essential spawning and juvenile nursery habitats through coastline development, coupled with sea level rise, poses a threat to all four species. HSC's in Southeast Asia face multiple threats, including overharvesting for use as food and biomedical purposes, and the lack of species and habitat protections and/or inadequate enforcement of existing regulations. In contrast, the commercial exploitation of American HSC's for bait in the eel and whelk ("conch") fisheries is well managed by the Atlantic States Marine Fisheries Commission. However, the limited allowable harvest of HSC's by the US bait fishery has had an unintended side-effect: several thousand crabs from Thailand and Vietnam have been legally imported to the US in the last two years to meet the demand. While no live Asian crabs would be released by eel or whelk fishermen, we believe there is a potential to introduce non-native epibionts, parasites, and diseases into US waters. Furthermore, allowing the importation of Asian HSC's provides an economic incentive for fishermen in Asia to further deplete those resources. The HSC Specialist Group has taken an active role in bringing these concerns to the attention of the appropriate State and Federal agencies, and a status report will be presented.

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AN EPISODIC DROUGHT DRIVES UNPREDICTABLE AND PERSISTENT CHANGES TO A FRESHWATER PREY SUBSIDY IN A SUBTROPICAL MANGROVE ESTUARY

Global climate change will not only result in shifting trends in average conditions, but also in increases in the frequency and intensity of climatic extremes. Though previous research has documented how climate extremes alter processes within ecosystems, few studies have examined their effects on energy flow between ecosystems. In 2011, an episodic drought impacted south Florida and the Everglades, substantially reducing the number of days that estuarine regions and surrounding freshwater marsh floodplains received freshwater. We expect that reductions in freshwater flow driven by the drought likely altered Everglades marsh fish communities that function as important seasonal prey subsidies to consumers living in adjacent estuaries. Thus, our research objectives were to test 1) whether the 2011 drought altered the composition, size and duration of freshwater prey subsidies to estuarine consumers and 2) document the legacy of the climate extreme on these freshwater prey subsidies. To address these objectives, we sampled the diets and abundances of both freshwater and estuarine fishes at the marsh-estuarine interface monthly between 2010 and 2013. One year after the drought in 2012, the composition and duration of the subsidy shifted from a pulsed subsidy dominated by sunfishes, to a long-lived continuous subsidy of large crayfish. In 2013, the species composition of the subsidy returned to sunfishes however, the body size of sunfishes doubled compared to those of pre-drought conditions. With increases in the frequency of climate extremes, we may expect changes in the nature of prey subsidies, such that they may become less predictable and more variable in their size, timing and duration. This will likely affect their importance and role to recipient ecosystems.

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COLLABORATIVE ADAPTATION PLANNING FOR SEA LEVEL RISE ALONG THE US-MEXICO BORDER

The Tijuana River Valley (TRV) contains the largest intact coastal wetland system in Southern California, despite intense pressure from development associated with being situated on an international border between two major metropolitan areas- San Diego (California, United States) and Tijuana (Baja California, Mexico). Unlike most other coastal ecosystems in the region, which have been fragmented or lost altogether, the Valley has contiguous beach, dune, salt marsh, riparian, and upland ecosystems. Through the Climate Understanding & Resilience in the River Valley (CURRV) project, the Tijuana River National Estuarine Research Reserve (TRNERR) is conducting a vulnerability assessment focusing on the relationship between sea level rise, riverine flooding, and sedimentation. The results of the assessment will inform the development of a climate adaptation strategy for the public agencies that own or manage land in the TRV, addressing the potential impacts that threaten the future resiliency of important natural ecosystems and surrounding human communities. This presentation will introduce audiences to collaborative climate adaptation planning in the San Diego region and more specifically the CURRV process, providing a unique case study of how TRNERR is improving the ability of public agencies to adapt to climate change, as well as offer tools for effective participatory ecosystem-based management in light of these changes.

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SHORT-TERM MUDFLAT DYNAMICS DRIVE LONG-TERM CYCLIC SALT MARSH DYNAMICS: EXPERIMENTAL EVIDENCE FOR UNDERLYING MECHANISMS

An important threat of sea level rise to salt marshes may be posed by lateral erosion. We still lack mechanistic understanding of the processes controlling marsh edge dynamics: i.e., the on a decadal time-scale alternation between lateral marsh expansion onto the mudflat and lateral marsh retreat by cliff erosion. We identified i) the mechanisms that initiate cliff formation on a previously lateral expanding marsh, and ii) the processes that control seedling establishment in front of a retreating marsh-cliff. Field measurements revealed that short-term sediment dynamics at the mudflat (i.e., seasonal and shorter) causes variation in mudflat elevation (δz) over time, with the amplitude of δz increasing with distance away from the marsh. Field experiments revealed that when δz become too large near a stable marsh edge, this can form a cliff by creating a height difference (ΔZ). Subsequent cliff erosion rate was found to depend on ΔZ and sediment stability. Thus marshes become more prone to erosion the further they extend on the tidal flat, where δz is larger. Laboratory and field experiments revealed that seedling establishment (and thus the onset of lateral marsh expansion in front of an eroding marsh) was also highly sensitive to δz. As seedlings survival increased with decreasing sediment dynamics, the chance of successful seedling establishment on the tidal flat increases with the distance that the marsh has eroded away from the waterfront. Our findings explain how increase in sediment dynamics along the mudflat, increases the risk for cliff formation and decreases the chance for seedling establishment towards the waterfront. Moreover, it shows that short-term (i.e., seasonal and shorter) sediment dynamics on the tidal flat determines the long-term (decadal and longer) cyclic behavior of the marsh. This process-based understanding is highly important for application in management and restoration for nature and coastal protection.

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TEMPORAL INVESTIGATIONS OF MARSH ECOSYSTEMS (TIME)

The Tijuana River National Estuarine Research Reserve (TRNERR), located in Imperial Beach, California, is part of a national system of ecologically important estuaries managed as partnerships between the National Oceanographic and Atmospheric Administration and various state agencies. While the ecosystem is the largest intact coastal wetland system in Southern California, there are challenges with regard to managing this system related to development on both sides of the boarder. Strengthening our understanding of changes in climate and developing strategies that address impacts threatening the future sustainability of natural ecosystems and human communities can help maintain and improve the resiliency of the Tijuana River Valley (TRV). The Temporal Investigations of Marsh Ecosystems (TIME) project is using collaboration and applied science to use information from the past and present, coupled with projections of climate change impacts, to steer wetland recovery. This participatory effort brings stakeholders together to create a decision-making framework for southern California, using the TRV as a model. By using a collaborative framework, TRNERR is leading a team that builds on well-established partnerships through the Tijuana River Valley Recovery Team and the Southern California Wetlands Recovery Projects. The effort is also expanded to include perspectives among a variety of stakeholders throughout the development and implementation to ultimately offer tools for effective ecosystem-based management. The Collaborative Learning Methodology employed in this project provides a vehicle to effectively obtain stakeholder's perspectives of challenges, barriers, attitudes,

and values. Combined with a scientific understanding of the TRV, tools such as a decision-making framework and visual models will be developed. The lessons learned from this collaborative science approach can be broadly applied to similar efforts in other coastal systems.

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BEYOND THE BLADE: SOILS IN DISTURBED AND RESTORED SUBTROPICAL SEAGRASS MEADOWS

Physical disturbance is a key contributor to global decline in seagrasses, but recovery trajectories are not well understood. Vessel groundings frequently damage shallow seagrasses near population centers, creating an opportunity for studying ecosystem response to disturbance and restoration. Specific restoration methods that stabilize soils and provide fertilizer input are used by resource managers to accelerate recovery of vessel grounding disturbances. This study evaluated proxies for secondary production, habitat quality, benthic metabolism, remineralization, and nutrient storage in disturbed and restored seagrass meadows up to five years old. Beyond removal of macrophyte biomass, disturbance to seagrass soils resulted in loss of stored nutrients including “blue carbon”, and altered microbial and infaunal communities. Evidence of the effectiveness of restoration actions was variable. Fill placement prevented additional erosion, but the resulting soil matrix had different physical properties, low organic matter content and nutrient pools, reduced benthic metabolism, and less primary and secondary production. Fertilization was effective in increasing nitrogen and phosphorus availability in the soils, but concurrent enhancement of seagrass production was not detected. Convergence of plant and soil response variables with reference levels was not detected via natural recovery of disturbed sites, or through filling and fertilizing restoration sites. However, several indicators of ecosystem development suggest that early stages of ecosystem development have begun at these sites. Physical disturbances such as vessel grounding in seagrass ecosystems create more complex and persistent resource losses than previously understood by resource managers. While the mechanics of implementing seagrass restoration actions have been successfully developed by the restoration community, expectations of consistent or rapid recovery trajectories following restoration remain elusive.

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ANTHROPOGENIC NUTRIENT SUPPLY AS A DRIVER OF MICROBIAL COMMUNITY STRUCTURE AND FUNCTION IN COASTAL SYSTEMS: EXAMINING DISTURBANCE PATTERNS IN RESPONSE TO A MAJOR ECOLOGICAL AGENT OF CHANGE

Increasing supplies of nutrients from multiple anthropogenic sources have fundamentally restructured much of the ecology of coastal ecosystems, but necessary methods to examine this restructuring at microbial scales have only recently been introduced. Salt marshes, in particular, filter out tremendous amounts of anthropogenic nitrogen but the role that this increased nitrogen supply plays on the functional ecology of marsh microbial systems remains unclear. I will present data from multiple marsh fertilization experiments that suggest that while the overall community structure of the microbes, as revealed by pyrosequencing of the 16s rRNA gene, remains relatively stable when comparing fertilized to reference marshes, a more nuanced approach with sequencing tools specifically designed to target the genes actively involved in nitrogen cycling indicate a considerable effect of fertilization on the structure of these functional microbial communities. In particular our results suggest that genes that encode enzymes directly responsible for the removal of fixed nitrogen from salt marshes via denitrification do tend to show greater richness and more community similarity in highly fertilized marsh plots compared to adjacent unfertilized areas of the marsh.

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FUNCTION AND MANAGEMENT OF DYNAMIC SEASONAL ESTUARIES: IDENTIFYING PHYSICAL AND BIOLOGICAL DRIVERS OF ECOSYSTEM FUNCTION AND RESILIENCE

Estuaries are inherently dynamic systems and seasonal or bar-built estuaries are especially dynamic, at times connected to the ocean and estuarine and at other times hydrologically disconnected from the ocean by a sandbar. The sandbar is thought to be a key driver, with likely direct and indirect changes to the physical environment and ecosystem. We examined the complex changes to ecosystem function associated with creation and loss of the sandbar, to establish causal links between biological and physical drivers of ecological function- invertebrate production and habitat quantity and quality- in seasonal estuaries. An interdisciplinary approach was used to understand physical and ecological processes associated with bar state in California seasonal estuaries, including: - How do bar state, water movement, nutrients, water quality, and primary production directly and indirectly change ecosystem function- habitats and invertebrate production? - Do these relationships hold across estuaries? - How do key functions change with extreme events, such as temperature spikes? - Are these ecosystems resilient? Data synthesis of monitoring data investigated physical drivers, while case studies of a subset of estuaries investigated the complex relationships between physical and biological drivers and ecosystem function. Conceptual models of ecological process and function were built through synthesis and case studies, and used to identify major drivers of key ecosystem processes – habitat quality and quantity and invertebrate production. Drivers included: mouth state, water quality, nutrients, and algal production. The results are considered in the context of resilience, to determine the mechanisms that promote recovery and persistence of communities and ecological function with disturbance, and evaluate if resilience is an appropriate management goal. The results can predict how key processes will change with changes in drivers, such as management actions or climate change.

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ECOLOGICAL RE-ENGINEERING OF A FALLOW AGRICULTURAL DYKELAND FOR TIDAL WETLAND RESTORATION IN A MACRO-TIDAL SYSTEM

The purpose of this paper was to examine the natural recovery of vegetative, sedimentary, nekton and hydrologic response to ecological re-engineering of a fallow agricultural dykeland site in the macro-tidal Upper Bay of Fundy. Restoration of tidal flow to a 13 hectare (32 acre) section of agricultural dykeland along the St. Croix River (Nova Scotia, Canada) was undertaken in 2009. A series of breaches in the dyke and channels constructed to re-connect the site to the river, which triggered significant self-organization within the restoration site. A six year monitoring program, based on the GPAC Tidal Wetland Restoration Monitoring Protocol, was developed. Previous works examining natural salt marsh vegetation (self design) recovery have shown that projects are most successful when: (1) there is no restriction on the dispersal ability of target species near the restoration site, and, (2) there is a disturbance to remove non-target species within the restoration area. The high rate of sediment deposition over the first year following restoration (>23 cm) resulted in the creation of mudflat conditions over much of the site. High resolution, low-altitude geo-referenced aerial photography was used to better understand factors influencing vegetation recovery and surface changes. Preliminary hydrogeomorphic analysis showed the reactivation of old agricultural ditches into the new hybrid drainage network. The vegetation survey showed a change of vegetation dominance from pasture grasses to wetland species within the first year of restoration. Preliminary image classification showed that exposed mud exceeded vegetated patches during the first growing season and that colonization of wetland species primarily occurred near secondary drainage channels following the return of tidal waters and sediment deposition. The results of the first three years of post-restoration monitoring are presented.

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SEASONAL SHIFT IN THE RELATIVE IMPORTANCE OF INVERTEBRATE AND VERTEBRATE GRAZERS IN A SAN FRANCISCO BAY EELGRASS BED

Herbivory enhances seagrass growth when grazers target competing algae, but grazers may also directly consume plant tissues. Additionally, nutrient availability can interact and be a strong determinant of seagrass growth. In eelgrass (Zostera marina) beds worldwide, ecologists in the Zostera Experimental Network have been conducting identical field experiments testing the relative importance of small crustacean grazers and nutrients to determine the degree of commonality in governing factors across the plant’s geographic range. In these experiments, mesograzers were reduced by a chemical deterrent and nutrients supplied through slow-release fertilizer. In San Francisco Bay, the fall influx of migrating Canada Geese (Branta canadensis) led to an additional treatment using exclosures to assess the relative importance of invertebrate and vertebrate grazing. Nutrient addition had little effect on Z. marina or epiphyte growth. At 4 weeks, the caprellid amphipod Caprella cf drepanochir and the gammarid amphipod Ampithoe valida represented 94% of the invertebrate abundance, and deterrent application led to >85% reduction in both species. While our previous work showed that A. valida can reach very high densities in late summer and directly consume eelgrass leaves and fruits, densities were low during this fall study and experimental reductions had little effect on Z. marina. At 8 weeks (late November), nearly all mesograzers were absent regardless of treatment. At this time Canada Geese were present in large numbers and began removal of Z. marina throughout the intertidal bed in all open plots. These geese damage basal meristems, leading to massive bed mortality, with recovery through seed in the spring (an annual life history). Offset timing of invertebrate and

vertebrate grazing could minimize the magnitude of top-down control, but bed recovery each spring relies on adequate sexual reproduction to counter amphipod damage prior to geese removal of perennating tissues.

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PREDICTING EFFECTS OF CHANGING SALINITY ON NATIVE AND INVASIVE SUBMERGED PLANTS IN THE UPPER SAN FRANCISCO ESTUARY

Native submerged aquatic vegetation (SAV) provides habitat for estuarine organisms, but its abundance and distribution may be impacted by shifting salinity regimes and interactions with introduced SAV. In the San Francisco Bay and Sacramento-San Joaquin Delta (the Estuary), salinities are projected to rise due global climate change and water management practices. It is uncertain how native SAV, Stuckenia spp., will respond to altered salinity or interact with the dominant SAV invader, Egeria densa in the future. Through a mesocosm experiment, we have measured the effects of salinity (0, 5, 10, and 15 ppt) on survivorship and competition between Stuckenia and Egeria. In the freshwater treatments, Egeria outcompeted Stuckenia with the latter producing 3.6 times less dry biomass in mixed culture than in monoculture (p=0.028). At 5 ppt, Egeria produced little biomass with no significant difference between mixed and monoculture treatments (5 & 55% increase, respectively). Stuckenia growth was not suppressed by 5 ppt and acquired as much biomass as in the freshwater treatments whether grown alone or with Egeria (323 & 375%, respectively). At the higher salinity treatments, Egeria died within three weeks. Stuckenia, on the other hand, produced new biomass in 10 ppt and survived in the 15 ppt treatment. Currently, competition likely limits Stuckenia in the fresher waters of the Delta, but rising salinity could lead to an eastward distribution shift as Egeria becomes too stressed to compete. As salinities change within the upper Estuary, these data will help to predict how distributions of native and non-native SAV will shift, and help to inform conservation and control efforts in the Estuary.

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PRIMARY PRODUCTIVITY ALONG THE RIVER-DOMINATED SHORELINE OF THE BAY OF SAINT LOUIS ESTUARY, MISSISSIPPI: TEMPORAL AND SPATIAL VARIABILITY

Potential primary production was measured for six consecutive months (July 2010 to December 2010) at selected stations along the shoreline of the Bay of St. Louis (BSL) estuary. Monthly surface and a series of subsurface (0.5 m) samples were taken to observe the temporal (monthly and short-term) and spatial variability in production relative to environmental variables that potentially could influence phytoplankton photosynthesis. Daily areal primary production, P was modeled using photosynthesis-irradiance (P-E) parameters in conjunction with in situ irradiance measurements and biomass data collected during sampling. Production varied seasonally and ranged from 1.90 g C m-2 d-1 in July to 0.06 g C m-2 d-1 in December. Short-term variability also was observed. Production ranged from 0.25 to 0.84 g C m-2 d-1over the course of a week and within-day values ranged from 0.36 to 0.72 g C m-2 d-1 with peak production occurring at midday. Temporal variability was attributed primarily to changes in temperature (seasonal), river discharge (week-long), and incident irradiance (diurnal). Spatial variability was not observed, suggesting that P did not differ significantly ($p < 0.05$) between stations over the course of the study. Annual production for the BSL estuary was estimated at 197.3 g C m-2 y-1 and is comparable to other temperate, mesotrophic estuaries. The results from this study provide the first modeled estimates of primary production within the BSL system and will facilitate ecological research and monitoring efforts within this locally important estuary.

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SEDIMENT FLUX MODELING OF BIVALVE AQUACULTURE SPATIAL IMPACTS ON SEDIMENTS (BASIS)

Bivalve aquaculture relies on naturally occurring phytoplankton and detritus as food sources, thereby avoiding external nutrient inputs associated with finfish aquaculture. However, high filtration rates and concentrated biomass of bivalves focus intense particle deposition on surrounding sediments, with potentially adverse environmental impacts. Estimating this depositional flux is notoriously difficult due to methodological constraints and dynamic processes such as resuspension and advection. This study used a pattern search algorithm and a mechanistic sediment flux model to estimate seasonal particulate organic carbon deposition in the vicinity of an eastern oyster farm in the lower Choptank River, MD, USA. The model is the standalone version of the two-layer sediment flux model (SFM) currently implemented for Chesapeake Bay TMDL management. The pattern search algorithm tunes the depositional flux to fit ammonium flux at a transect of sites from the farm to a control site in the open estuary. Subsequently, modeled sediment-water fluxes were compared to observed denitrification rates and nitrate fluxes. Thus, this method calculates the aerobic layer depth and integrated measures of nitrogen cycling as a function of seasonal farm dynamics. Model derived estimates of biodeposition were compared with sediment trap estimates as well as estimates from a particle tracking alrgorithm in a fine scale hydrodynamic model that accounts for tidal flows and wind-waves. Large differences between modeled and sediment trap derived estimates highlight the role of sediment erodability and episodic events in transporting biodeposits away from this particular farm, resulting in a diminished local environmental impact.

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THE EFFECT OF OCEAN ACIDIFICATION ON BENTHIC ECOSYSTEM FUNCTIONING IN CONTRASTING SEDIMENT TYPES

Research so far provided little evidence that benthic ecosystem functioning is affected by ocean acidification. However, most of these investigations did not take into account seasonality, and sediment type. While coarse, permeable sediments make up the bulk of coastal sediments, they are largely neglected in acidification research as most of the research was targeted towards relatively fine sediments. We investigated whether a pH decrease of 0.3 affects sediment community oxygen consumption (SCOC), nutrient exchange, nitrification processes and alkalinity generation in coastal permeable and non-permeable sediments. The effect of advective currents through permeable sediments was taken into account by using benthic stirring chambers for our incubations. As benthic ecosystem functioning is largely affected by the seasonality of phytoplankton bloom deposition, we repeated our incubations in February, April and September 2012. In all months, vertical oxygen profiles confirm the well-known deeper oxygenation of permeable sediments compared to non-permeable sediments. Fluxes were generally most pronounced in the non-permeable sediments. Our most striking result however, was a lower SCOC in February in all treatments with a decreased pH compared to ambient pH. This suggests that benthic oxygen consuming processes (i.e. nitrification) are hampered at lower pH, which is indeed corroborated by lower nitrification estimates in these treatments. During phytoplankton bloom (April), these patterns were not clear. During the post-bloom period (September), lower nitrification rates in acidified treatments were only observed in the non-permeable sediments. As such, it appears that ocean acidification effects on benthic ecosystem functioning are dependent on sediment type and on timing with respect to the phytoplankton bloom deposition.

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INVESTIGATING TIME VARIATIONS IN DOC CONCENTRATIONS FOR SALT MARSH CARBON BUDGETS: TESTING CONTINUOUS FDOM MEASUREMENTS AS A PROXY

One way to combat climate change is to protect and restore ecosystems, such as marshes, that sequester carbon. There is currently not enough data about marsh carbon cycling and budgets to generalize about their carbon storage capacity. Particularly, there is little known about the tidal or "lateral" exchanges within the marsh carbon cycle. This study examines the lateral exchanges of one piece of the carbon cycle; dissolved organic carbon (DOC). Due to lack of instrumentation, continuous in situ DOC measurements are difficult to make. Therefore, this study tests the possibility of using the fluorescence portion (FDOM) of dissolved organic carbon as a proxy for DOC in situ flux studies, and also investigates time variations in FDOM and DOC. A WET Labs ECO-fluorometer was used to collect FDOM data in the field while an OI Analytical high temperature combustion TIC/TOC analyzer was used to analyze discrete DOC samples. A strong positive correlation was observed between FDOM and DOC concentrations for both rising (R2=0.8977) and falling tides (R2=0.9365). The average DOC value for the study period was 1.96 ppm. FDOM/DOC concentrations were higher during low tide (average FDOM: 0.296 volts) than high tide (average FDOM: 0.206 volts). A correlation between tidal amplitude and FDOM/DOC peak amplitude was also observed in the June data with an R2=0.9923. Further research is needed to determine whether the FDOM/DOC correlation holds over other seasons and to determine the cause of the FDOM/DOC peaks around low tide.

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SALT WATER INTRUSION AT A POINT SOURCE OF SUBMARINE GROUNDWATER DISCHARGE IN A REEF LAGOON

Sea level rise poses a serious threat to coastal communities and ecosystems. One of the most severe threats relates to salt intrusion in coastal aquifers, potentially degrading the quality of groundwater resources. Recent studies have found that in both confined and unconfined aquifers, salt water intrusion due to SLR will initially pose a threat to groundwater resources, but overtime, the salt intrusion may be mitigated by a natural process called the "lifting process." However, this research did not incorporate semi-confined aquifers with submarine groundwater discharge. Our study will attempt to replicate the lifting process mechanism and incorporate SGD in a shallow lagoon estuary environment. It is hypothesized that in a semi-confined aquifer with SGD sources, saltwater intrusion will have an enduring adverse affect and will not return to the initial interface location. This hypothesis will be validated through numerical simulations in MODFLOW and SEAWAT using varying SLR predictions. These varying SLR results will be essential in forecasting future impacts on available groundwater resources.

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A STUDY OF THE EFFECTS OF CULTURED VS. WILD OYSTERS (*CRASSOSTREA VIRGINICA*) ON NITROGEN CYCLING AND ECOSYSTEMS WITHIN TWO SIMILAR, EUTROPHIC ESTUARIES IN CAPE COD, MA

The removal of excess nitrogen from estuarine systems through the enhancement of shellfish stocks has become a popular activity among coastal scientists and managers. The town of Falmouth, Massachusetts has embarked on a demonstration project to study the extent that the culture of oysters (Crassostrea virginica) can enhance water quality in Little Pond, a relatively small estuary receiving a high nitrogen load. Approximately 2.5 million seed oysters are being grown in surface shellfish nursery gear in Little Pond for at least 2 years. A monitoring program is being conducted throughout this project to determine whether measurable changes in water quality and other ecological indicators can be achieved. Hypothesized reductions in nitrogen concentration, phytoplankton standing stock, and the frequency of low DO events are being quantified through the comparison of current data to previous monitoring programs in the estuary. We have also discovered a significant natural set of oysters in a nearby estuary, Salt Pond. We have initiated a water quality monitoring program in Salt Pond, including a stock assessment and genetic studies to determine the degree of relatedness and effective population size. As in Little Pond, previous water quality monitoring data are being used to measure the effect of the oysters on the nitrogen cycle and the potential for cascading ecological responses (e.g., improved water clarity, lower phytoplankton standing stock, and possibly lower nitrogen concentrations). We are also tracking changes in water quality as this large standing stock of oysters matures and/or succumbs to mortality. The two studies are running in parallel and offer a unique opportunity to understand the role that wild and cultured oysters play in nutrient and ecosystem dynamics in the south coastal estuaries of Cape Cod.

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SPATIAL AND TEMPORAL DISTRIBUTION AND ABUNDANCE OF ICHTHYOPLANKTON FROM 2012-2013 IN SAN DIEGO BAY

Bays and estuaries are vital nursery areas for nearshore marine fishes as they provide food, shelter, and adequate physical conditions for development of eggs, larvae, and juvenile fishes. Studies have documented dependence of coastal fishes on semi-enclosed bodies of water for at least a portion of their lifecycles. San Diego Bay is the largest naturally occurring marine embayment between San Francisco and Scammon's Lagoon in central Baja California and is heavily industrialized. Despite anthropogenic influences on the bay, it serves as a nursery for several fish species. However, information regarding the distribution of planktonic life stages of fishes in San Diego Bay is limited. The purpose of this study was to describe the temporal, seasonal, and spatial variation of ichthyoplankton in each of the four distinct regions in San Diego Bay. Monthly diurnal and nocturnal samples were collected from May 2012 – April 2013 along four transects in San Diego Bay via a surface manta net. Transect lines were designed to sample across different habitats and depths at each location. Samples were rinsed, fixed, stored and processed before they were sorted by ichthyoplankton, fish eggs, debris, other plankton, and organic material. Combined weights were taken for each category as well as a total weight of the sample. Fishes were identified to the lowest taxonomical level. Ichthyoplankton has been identified in all samples. Nocturnal samples appear to be denser than diurnal samples and spring samples were densest compared across seasons. Ichthyoplankton abundance has been varied across all sites and demersal, benthic, pelagic, and Bay-specific species have been observed in the samples. Samples collected are indicative of species-specific spawning events. This is the first study investigating ichthyoplankton distribution by ecoregion in San Diego Bay which may be the most important factor explaining variability in fish larval and egg concentrations.

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MANGROVE PONDS: A MODEL SYSTEM FOR STUDYING ACIDIFICATION, HYPOXIA AND INCREASING WATER TEMPERATURES

Systems that are naturally acidic can provide important insight into the ecological and evolutionary effects of atmospheric carbon dioxide-driven acidification and of diel-cycling pH and hypoxia, rhythms exacerbated by increasing anthropogenic nutrient loads. During 2011-2012 we sampled ponds in Twin Cays, Belize and Bocas del Toro, Panama that form in the interior of mangrove (Rhizophora mangle) islands but remain connected to outside waters. Physical conditions in some ponds were similar to those in the outside channel or coral habitats. In others, pH levels dropped as low as 6.9 and oxygen concentrations become near-anoxic during early morning hours, and in shallow systems in Belize, temperatures reached 40oC during mid-day. Total alkalinity in the Panama ponds ranged from 1956-2068. Especially on the depositional side of ponds, magenta-colored layers (presumably Chromatium bacteria) were within mm of the sediment surface. Many of these ponds support large populations of schyphomedusea, especially the benthic photosynthetic Cassiopea spp., as well as green macroalgae. Sea stars and sea urchins were notably absent from ponds, brittle stars were restricted to mangrove roots in pond channels, and in the most severe systems, benthic finfish diversity was extremely limited. We suggest that these mangrove ponds could be developed as important model systems for the study of acidification, hypoxia and extreme environments in general.

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CROSS SYSTEM COMPARISONS- FINDING THE HUMAN FOOTPRINT AT A RANGE OF SPATIAL SCALES

A hallmark of Scott Nixon's research was the use of cross-system comparisons to improve our understanding of both processes and patterns in marine and estuarine systems. I've often started talks with a figure from Scott's work showing that fisheries landings generally increase with increasing N loads despite clear environmental degradation caused by high anthropogenic nutrient loadings and negative effects, such as fish kills, at the local scale. Differing ecological effects of nutrients and associated hypoxia at system and local scales can make predicting the benefits of nutrient reductions difficult. At a somewhat smaller scale, predicting effects of local shoreline alteration can be difficult because it occurs within the context of subestuary-scale land alteration. For both of these topics, cross-system comparisons have been valuable tools to move beyond quirks of individual locations and systems. The HYPOFIN working group has compiled a global database designed to better understand the effects of nutrients and hypoxia on food webs and fisheries. Our results indicate that the mean trophic level in fisheries catches declines with increasing nitrogen loads. Furthermore, the standing biomass of mobile consumers per unit nitrogen (i.e., the efficiency of consumer biomass production) decreases with increasing extent of hypoxia, although total mobile consumer biomass does not decline. In addition, data from 7 research institutions and agencies indicate that increased crop and developed land in subestuaries of Chesapeake Bay and the Delaware coastal bays is associated with reduced abundances of several important fisheries species. However, effects of shoreline hardening depend on the surrounding land use. Due to differences in the human footprint measured at different spatial scales, clear decisions are required on the spatial scales that are of concern to society in order to more acurately match management goals and predicted benefits.

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DERIVATION OF PROTECTIVE NUMERIC NUTRIENT CRITERIA FOR SOUTH FLORIDA ESTUARIES AND COASTAL WATERS

Water quality in South Florida's estuaries and coasts is the result of a long-term and poorly understood interplay of local, regional and global forcing, drivers, and responses, including the impacts from anthropogenic interventions since the early 1900's. A holistic approach to basin segmentation before NNC derivation was selected to account for variability not only dictated by a given nutrient level, but by the combination of imposed conditions (nutrients, geomorphology, circulation, management, etc). FIU's water quality monitoring data at 353 fixed stations was used for basin segmentation combining PC analysis and clustering methods in tandem. Forty water bodies were outlined, extending from Biscayne Bay (east) to Dry Tortugas (south) to Pine Island (northwest). Nutrient (TN, TP) concentration thresholds for each segment were derived, by identifying concentrations that were associated with above average increases in CHL-a. For this purpose, CHL-a z-scored cumulative sums were plotted along either TP or TN gradients, mimicking nutrient dose-experiments. These graphs illustrated the successive reactions of phytoplankton biomass to nutrient enrichment, highlighted the main threshold, and provided information showed to assess the potential health status of phytoplankton communities in the water column. Although threshold calculations were segment-specific, their levels transcend segment boundaries, resulting in a regional stepwise pattern, perhaps dictated by specific phytoplankton assemblages. Calculated thresholds would fix the limit for nutrient concentrations above which a long-term NNC would not be considered protective of the actual segment conditions with respect to phytoplankton biomass. We propose the threshold as long-term NNC for waterbodies in good ecological condition and supportive of its designated use

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HOW IMPORTANT IS NUTRIENT REMOVAL THROUGH SHELLFISH HARVEST IN LONG ISLAND SOUND AND GREAT BAY-PISCATAQUA ESTUARY?

Eutrophication is a significant problem in many estuaries that have high watershed population density or large agricultural land use; seasonal water column stratification also contributes. As traditional land-based nutrient control (i.e. wastewater treatment) experiences diminishing returns on investment, complementary methods are being explored. A promising approach is shellfish aquaculture, since filter-feeding bivalves (e.g. oysters and clams) remove phytoplankton and detritus from the water, thereby reducing eutrophication by short-circuiting organic degradation and consequent effects on bottom water dissolved oxygen. We compare the importance of nutrient removal through shellfish aquaculture in Long Island Sound (LIS) with an industry of significant size, and Great Bay-Piscataqua Estuary (GBP) with a small but growing industry. Our approach combines field studies and models for system and local-scale assessment. Local control was simulated using culture practice and water quality data for selected farms. The model evaluated shellfish growth, nutrient removal and impact on water quality. Economics of the farm, including potential for additional income through an 'avoided cost' analysis is also examined. Local results are upscaled to existing farm area to provide an estimate of current nutrient removal using system-scale ecosystem models in LIS and by direct scaling of local rates to active farm area in GBP. We also estimate the extent of potential removal with respect to conditional areas and suitable areas that are presently unused, through expansion of aquaculture into those areas. Our results will determine whether shellfish aquaculture is a feasible complement to traditional land-based nutrient controls using present and potential removal estimates. They will also provide the basis for evaluating the role that shellfish aquaculture might play with respect to additional revenue from product sales within nutrient credit trading programs.

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APPLYING MENTAL MODELING TECHNOLOGY™ TO DEVELOP STATE-OF-THE-SCIENCE STAKEHOLDER ENGAGEMENT AS PART OF THE ENGINEERING WITH NATURE INITIATIVE FOR THE USACE ENVIRONMENTAL LABORATORY

With recent advances in the fields of engineering and ecology, the U.S. Army Corps of Engineers' (USACE) has developed the Engineering With Nature (EWN) initiative to enable more sustainable delivery of economic, social and environmental benefits associated with water resources infrastructure. A key EWN focus is on creating new ways of conducting business and expanding the benefits of USACE infrastructure projects through effective partner and stakeholder collaboration. It proposes a paradigm shift from the current decision making model, perceived by some as confrontational, to one of more effective decision making through early and ongoing collaboration with partners and stakeholders. As part of this multi-year initiative, the USACE has undertaken a Mental Modeling approach, applying Mental Modeling Technology™ to: systematically engage and collaborate with key stakeholders on the design and implementation of EWN; identify influences on adoption of EWN within both USACE and key partner organizations; and develop strategic communications and stakeholder engagement practices to support and promote EWN. MMT™ is ideally suited to advancing EWN through applied strategic risk communications due to its ability to generate in-depth, evidence-based factors influencing decision making and behavior. This insight is used to develop focused strategies, plans and communications to effectively address the complex, multi-stakeholder issues and challenges related with EWN projects and to integrate knowledge and technical expertise from multiple stakeholders and partners. This presentation will focus on the application of this science-informed approach to EWN and progress to date.

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THE ROLE OF TURBULENCE IN THE EROSION OF COHESIVE SEDIMENTS

The erodibility of muddy sediments was investigated with a diver-operated mini-flume at four locations outside of Atchafalaya Bay in 5.1-6.5 m water depth in June 2012. The mini-flume was placed on the seabed and oriented such that the effluent would be directed away from the incurrent opening by wave/tidal currents. Bottom stress was applied with a battery-powered ROV thruster at levels of 0.03, 0.06, 0.16, 0.22, and 0.29 Pa. Suspended sediment concentration was measured with an OBS-3 sensor near the effluent opening of the flume and simultaneously current velocity and turbulent kinetic energy was measured with a Vectrino profiling ADV hardwired to a data logger aboard ship. The ADV obtained a profile of velocity within 3 cm of the seabed with measurements spaced at 1 mm. There does not appear to be a pattern of large initial erosion and quasi-exponential decay associated with each of the increased stress levels. Instead, there are discrete episodes of sediment mobilization that occur after the increase in fluid stress and during the periods of constant applied stress. Furthermore, preliminary estimates of peak turbulent kinetic energy from the ADV integrated over bins at the height above the seabed where the OBS measured the suspended sediment appear to correlate well with peak suspended sediment concentrations. Consequently, we suggest that these episodic peaks in measured suspended sediment concentration are the result of turbulence. We plan to conduct more measurements in locations of mixed sand and mud sediments and sediments with tubiculous fauna, to determine the role of turbulence in eroding cohesive sediments. These in-situ measurements will be corroborated with core samples brought into a laboratory flume for intensive investigation with a high-speed tomographic particle image velocimetry system that measures the three-dimensional, three-component fluid velocity at high temporal and spatial resolution.

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HACCP: HAZARD ANALYSIS AND CRITICAL CONTROL POINT PLANNING—A RISK MANAGEMENT TOOL AND ITS USE TO DECREASE THE MOVEMENT OF INVASIVE SPECIES

Routine activities, including habitat restoration, monitoring, biological surveys, or collections, take biologists and equipment to numerous habitats and could be pathways for spreading nonindigenous species. It is our responsibility as natural resource professionals to strive to do no harm by understanding invasive species pathways and developing plans to prevent future spread. Hazard Analysis and Critical Control Point (HACCP) planning is a five-step tool that manages risk of moving invasive species during natural resource management activities. The steps involve recognition of reasonable non-target (or potentially invasive) species, management and assessment of potential pathways, identification of critical control points, and development and evaluation of control measures used to reduce risk to an acceptable level. By following simple steps, HACCP is designed to identify high-risk tasks and focus attention on actions needed to close pathways. Proper planning includes documenting the risk posed by an activity for moving invasive species, developing control methods to reduce such risks, and provides opportunity to weigh the benefits from natural resource actions against the risk of invasion. HACCP plans also create a reference source for documenting best management practices that can be shared with others to reduce this risk of invasion through similar pathways. In 2011, we updated a HACCP course to incorporate comments and suggestions from previous courses (please visit http://www.haccp-nrm.org for more information). In 2012, we developed a new Train the Trainer course for future HACCP instructors, an optional addition to the standard HACCP course which focuses on the development and implementation of HACCP plans. Upcoming course information is available from the U.S. Fish and Wildlife Service's National Conservation Training Center located in Shepherdstown, West Virginia.

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SEASONAL PATTERNS OF HORSESHOE CRAB SPAWNING (*LIMULUS POLYPHEMUS*)

Horseshoe crabs occur in a number of genetically distinct populations that differ in many traits including their seasonal patterns of reproduction. These population differences will affect how the species is managed in different parts of its range. Understanding seasonal patterns of reproduction in southern populations also provides insight into the likely effects of climate change on northern populations where the timing of breeding is crucial to their management as a resource for shorebirds. Here we discuss seasonal patterns of reproduction in a northern Florida, Gulf coast population of horseshoe crabs in which the animals have two breeding seasons, one in spring (Feb to May) and another in fall (Sep to Nov). We compare our results with breeding patterns of northern populations and with other Florida populations in which nesting occurs throughout the year. In this study we use environmental measurements, spawning surveys, mark-recapture, physical measurements of adults and their nests and laboratory rearing of eggs to compare seasonal patterns of reproduction. The spring and fall breeding seasons differ in a number of important respects including temperature, nesting densities, operational sex ratios, egg development rates and physical differences between the males and females that nest in the two seasons. Our results show that in our southern population, some males and a few females breed twice a year. Fall breeding animals are, on average, smaller and in better condition than those breeding in the spring. We show that nesting density, operational sex ratio and other seasonally variable factors influence the timing and numbers of eggs laid. With global climate change, the patterns of breeding that we see in Florida are likely to track northward. The breeding patterns of horseshoe crabs show considerable variation between populations as well as seasonal differences within populations, in what is widely regarded as a changeless "living fossil".

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THE INTERACTIVE EFFECTS OF AERIAL EXPOSURE AND COMPETITION WITH FOULING ORGANISMS DETERMINES JUVENILE OYSTER SIZE AND FITNESS IN AN EUHALINE MID-ATLANTIC ESTUARY

Eastern oyster reefs grow and persist along a narrow range within the intertidal zone in euhaline estuarine waters. Recent restoration efforts in North Carolina have shown that while settlement can be highest in shallow subtidal regions, post-settlement mortality results in greater densities in the intertidal zone, with greatest individual growth in the low intertidal. These differences across the exposure gradient may be due to the presence of bio-foulers in the subtidal, but we have yet to separate the mechanistic effects of the fouling community, sedimentation, and intra-specific density-dependent competition. We collected juvenile oysters in July by allowing larvae to settle on cultch shells. On each shell, spat density was standardized to remove any initial density-dependent effects and then suspended on racks to reduce sedimentation at four elevations within the sub- and intertidal zones (-0.9, -0.7, -0.5, and -0.3 m NAVD 88). To understand how competition affected juvenile oysters, all foulers on and around spat were gently removed from half of the shells every 10 days. Every three weeks, the fouling species on each shell were enumerated along with oyster density and size. We found that barnacles smothered spat on shells if the fouling community was allowed to persist, and by the end of August, removing bio-foulers increased the size of the surviving oysters. Four months after the experiment began, exposure time had an interactive effect with bio-fouler presence on size. When oysters did not have to compete with the fouling community, size was consistent across all elevations, but allowing the fouling community to persist resulted in significantly smaller oysters in the subtidal relative to the mid and low intertidal. This indicates that competition between fouling organisms and juvenile oysters is a major driver in the distribution of oysters across subtidal and intertidal environments.

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UPDATING OREGON'S ESTUARINE WETLAND HABITAT MAPS: MODERNIZING THE FOUNDATION FOR COASTAL RESOURCE MANAGEMENT

Oregon's estuarine wetlands provide valued ecosystem services, including organic matter production, nutrient processing, sediment detention, carbon sequestration, and fish and wildlife habitat. Recent estimates indicate that since European settlement, about 70% of Oregon's emergent tidal wetlands and 90% of Oregon's once-prevalent tidal swamps (shrub/forested tidal wetlands) have been lost through conversion to non-tidal wetlands or uplands. The last major statewide effort to map estuarine wetlands and develop estuary planning tools was in the early 1980s. Since that time, a wealth of new data have become available, and Oregon's state and local governments recognize a need for updated estuary habitat mapping to support current and future planning and resource management. This project generates updated mapping of Oregon's tidal wetlands and shorelands, and classifies these resources

according to the Coastal and Marine Ecological Classification Standard (CMECS), using a fusion of geographic datasets, expert knowledge, and other resources. A major challenge is to improve the accuracy of mapping for upslope and up-estuary limits of tidal wetlands, which have not been well-defined or accurately mapped in previous efforts. We determined this upslope boundary using digital elevation models derived from recently-acquired coastwide LIDAR, along with tide height modeling (annual exceedance values) from the National Oceanic and Atmospheric Administration's Center for Operational Oceanographic Products and Services (NOAA/CO-OPS). To support restoration planning and landscape change analysis, the mapping also includes former tidal wetlands such as diked pastures and filled lands. The products of this study will update the informational foundation for Oregon's estuary management program, allowing state and local governments to make better estuary planning and management decisions.

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COMPARISON OF NUTRIENT DRIVERS AND RESPONSE METRICS IN OREGON ESTUARIES

With the goal of assessing sensitivity to nutrient enrichment, we present a cross-estuary comparison of nutrient sources, levels, and biological responses (phytoplankton and macroalgae) for thirteen Oregon estuaries. Nitrogen levels in the upstream portions of the estuaries are related to forest cover in the watershed, while in the marine-dominated portions of the estuaries nitrogen levels are dependent upon ocean conditions. Phosphorous levels are primarily determined by ocean input. Stable isotope data of macroalgae are useful for distinguishing oceanic, watershed and wastewater inputs of nitrogen along an estuary. Variations in water column chlorophyll a levels among estuaries appear to be related to the variations in freshwater inflow to the estuaries. Patterns of nutrient limitation of phytoplankton were variable among systems and appear to be related to watershed characteristics. Macroalgal blooms varied among systems and were concentrated in the marine-dominated portion of the estuary. These results will aid in determining the expectation of causal and response variables for the development of estuarine nutrient criteria in the region.

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WHAT'S THE GIST? USING GIS TO TRACK THE COMPLIANCE OF BALLAST WATER MANAGEMENT IN CALIFORNIA

The California State Lands Commission's Marine Invasive Species Program (MISP) oversees the state's program to prevent nonindigenous species (NIS) introductions to California waters through the discharge of ballast water from all vessels greater than 300 gross registered tons capable of carrying ballast water. Ballast water discharge from commercial shipping is an NIS vector with a well-documented risk of species transfer associated with it. A vital component of the MISP is the requirement that vessels submit ballast water reporting forms upon departure from each port or place of call in California. These forms detail ballast water management activities for approximately 10,000 vessel arrivals each year, forming a robust data time-series through which compliance and management patterns can be examined, including geographic and temporal analysis of source and exchange patterns of ballast water that is eventually discharged within the state. The use of Geographical Information Systems (GIS) allows the MISP to assess compliance on several levels, including the source and management (ballast water exchange) locations of all reported ballast water discharges into California waters. GIS analyses can also illustrate broad patterns and processes, such as the amount of noncompliant ballast water discharge by location, which offers greater insight into potential NIS hotspots and areas of increased risk. Details of our ballast water management compliance analyses, including the quantities and geographies of managed ballast water, where such ballast water has been exchanged, and where it has been discharged, between 2006 and 2012 will be presented.

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EXTRACTING SEA LEVEL RESIDUAL FROM SHORT TIME SERIES IN TIDALLY DOMINATED ESTUARINE ENVIRONMENTS

Sea level comprises a mean level, tidal elevation and a residual elevation. Knowledge of what causes maximum water levels is often key in coastal management. However, different methods to extract deviations in water level (residuals) from modelled and observed elevation can give different results. The Dee Estuary, northwest England, is a macrotidal estuary that undergoes periodic stratification. It is used here to demonstrate methods to extract the residual water level in response to the following interactive processes: tidal, river induced stratification and flow, meteorological and waves. Using modelling techniques the interaction and contribution of different physical processes are investigated. Classical harmonic tidal analysis, model simulations and filtering techniques have been used to "de-tide" the total elevation for short-term (month long) records. Each technique gives a different result highlighting the need to select the correct method for a required study. Analysis of the residual components demonstrates that all processes inducing residuals interact with the tide generating a semi-diurnal residual component. It is suggested that modelling methods enable the full effect of tidal interaction to remain in the residual, while harmonic tidal analysis (partly) modify and filtering methods (fully) remove this component of the residual. The analysis methods are presented and their influences on the resultant residual discussed. When applied specifically to the mouth of the Dee Estuary, the external surge is found to be the main contributor to the total residual, while local wind and stratification effects are of secondary importance.

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OYSTER REEF RESTORATION IN THE NORTHERN GULF OF MEXICO: EFFECT OF MATERIAL AND AGE ON NEKTON AND BENTHIC MARCOINVERTEBRATE ASSEMBLAGES

With declining structural complexity in marine systems, and in turn a loss of refuge and habitat, there have been increased efforts to restore habitat. In the northern Gulf of Mexico, reefs built by the eastern oyster, Crassostrea virginica, provide critical habitat within shallow water estuaries, and recent efforts have focused on restoring reefs to benefit nekton and commensal populations. Nekton and benthic macroinvertebrate assmeblage were compared at historic reefs, newly-created (< 5 yrs) and old (> 6 yrs) shell and rock created reefs. Using baited crab traps, gill nets, otter trawls, cast nets, and commensal collectors, 20 reefs within shallow waters (<5 m) of the northern Gulf of Mexico were sampled throughout the summer of 2011. We compared nekton and benthic macroinvertebrate assemblage abundance, diversity and richness across reef types. While there were few differences in nekton communities between reef types, benthic macroinvertebrate assemblages differed by reef type with lowest diversity and abundance on old shell reefs. Old rock reefs had highest community indices, most likely due to greater amount of structure remaining compared to shell reefs over time. In a complementary laboratory study we tested the habitat preferences of juvenile crabs across depth and refuge complexity, in the presence and absence of predatory pressure. Juveniles were more likely to use deep water refugia when predators were present, but only when refuge was complex. The refuge value of structure seems to drive higher richness and diversity of macroinvertebrates on reefs. Creation of reefs for community restoration needs to ensure material support long-term sustainability.

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GENE EXPRESSION TO IDENTIFY AND FOLLOW LIKELY ACTIVE DIAZOTROPHS ALONG AN ESTUARINE GRADIENT

Marine sediments harbor extremely diverse nitrogen (N) cycling microbial communities, thus making it difficult to identify the functional groups and elucidate controls on their activity. Recently, benthic sediments from the estuary Narragansett Bay (RI) were shown to exhibit a seasonal switch in N cycling with high rates of net N_2 fixation, challenging the denitrification-dominated paradigm. To target the microbes that are the most likely players contributing to the inputs of N in the Bay sediments, we are following the expression of the functional gene for N_2 fixation (*nifH*). We detected the highest diversity of N fixers expressing *nifH* near the freshwater head of the Bay. The biodiversity decreases along the

gradient of the Bay, with the lowest levels observed at two offshore continental shelf sites. A group of microbes related to *Pelobacter carbinolicus*, an anaerobe with the ability to reduce iron and sulfur compounds, was identified at all sites. The remaining diazotroph community composition shifts from being predominated by microbes related to sulfate and sulfur reducers in the Upper Bay to one group related to an uncultivated marine cyanobacterium, *Candidatus* Atelocyanobacterium thalassa also designated UCYN-A, at the offshore sites. By targeting the microbes related to the sulfur and sulfate reducers, we have detected the highest abundance and *nifH* expression in the Upper Bay sediments. Several different ecological mechanisms including temperature, organic matter loading and oxygen concentrations may be driving the shift in biogeography patterns, abundance and expression of active N fixers. Field measurements of diazotroph community composition and *nifH* gene expression may provide insight into how these microbes react to and in turn influence conditions in their ecosystem.

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DIFFERENCES AMONG SALT MARSH DITCH EDGES AND PEAT STRENGTH WHEN EXPOSED TO A SPATIAL GRADIENT IN NITROGEN CONCENTRATION OVER AN INTERVAL OF DECADES

High nutrient concentrations may cause thinning in salt marsh peat and edge collapse in ditches. It is unclear whether the resulting lower root to shoot ratios and altered stability of ditch banks increases erosion over a period of decades or do the edges eventually stabilize. Several sets of aerial photographs from the time interval 1956 to 2012 were studied to asses the long term trends for ditch and creek edges in an estuary with a strong nutrient gradient. Records of nutrient concentrations for this estuary start in 1968 and indicate that high levels of nitrogen already existed at that time, reaching NO3 > 70 μm/l. Some infrequent edge failures and blocks are possibly seen in 1956 photos but may represent advanced edge failure. Recent photos and field visits do not indicate cracks and blocks from recent ditch edge edge failure. In locations with DIN> 60 μm/l, Spartina alterniflora has grown into many man made ditches while ditch mouths have widened. In locations where N concentrations are lower and declining (recent DIN<15 μm/l), regrowth into ditches is not proceeding as rapidly and the widening of ditches is occurring more evenly and extensively. In all locations the natural creeks have widened and show signs of meandering. Peat strength was measured and spatial patterns are presented across the estuary. It is concluded that the marsh edges exposed to high nitrogen concentrations for long periods may have reached an equilibrium. At least in this specific estuary, the higher rates of sediment capture reported in several marsh fertilization experiments seem to outweigh the weakening effects from thinning peat when trends are measured through time periods extending over several decades.

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CARBON AND NITROGEN STABLE ISOTOPE DYNAMICS OF *CRASSOSTREA GIGAS* LARVAE AT WHISKEY CREEK SHELLFISH HATCHERY

At Whiskey Creek Shellfish Hatchery (WCH) in Netarts Bay, Oregon, exposure to low aragonite saturation state water in early larval life has been associated with reduced survival and growth of *Crassostrea gigas*. The observed effects do not manifest until >10 days after sub-lethal exposure, implicating a mechanism of susceptibility with 'legacy' (e.g., energetic or developmental damage). Further, these impacts were documented under supersaturated conditions, indicating a non-thermodynamic control for sensitivity to ocean acidification. The creation of the initial "D-hinge" shell is energetically expensive, and recent work with carbon isotopes suggests that greater exposure to ambient conditions during initial shell development is an important process linking ambient water chemistry and larval susceptibility. We present stable isotope and biochemical data of one WCH larval cohort in May 2011 and two in August 2011. The May cohort experienced a low salinity event in early larval life and the first August cohort was exposed to an episode of moderate upwelling and a concurrent increase in pCO_2. The second cohort in August was raised in upwelled water buffered with Na_2CO_3. We used stable isotopes to compare maternal lipid and protein utilization, and track the incorporation of exogenous food through the larval period for each cohort. The May cohort used lipid reserves more rapidly than the August cohorts, preferentially used maternal reserves of protein over maternal lipids and did not isotopically reflect their food as rapidly, thus indicating either slower feeding or higher metabolic demand. We suggest that these patterns are indicative of severe energetic stress, and may be important indicators of legacy impacts. These data provide novel information on biochemical dynamics in early larval development and highlight the importance of maternal energy reserves in mitigating ocean acidification impacts in hatchery-raised larval *C. gigas*.

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A PALEOECOLOGICAL RECORD OF LONG TERM CONNECTIONS BETWEEN THE CHESAPEAKE WATERSHED AND ESTUARY

The connection between deforestation, agriculture and other human activities in the Chesapeake watershed and the degradation of the estuary is well documented by both paleoecological and modeling studies. During pre-colonial and early colonial time, beavers created wet marshy areas throughout much of the watershed. Ground water was close to or at the surface of the land due to minimal runoff of unevaporated rain water where there were few impervious surfaces. The resulting soggy and wet land created an anoxic environment that supported denitrification, thus reducing leaching of nitrogen into the soil and streams and ultimately the Bay. The early colonists first drained the land in order to plant crops. This combined with the near demise of beavers in the late 18th century for the fur trade transformed the land from wet to dry and in so doing decreased the potential for denitrification. Thus nitrogen compounds were leached into surface waters and ultimately the estuary. Evidence for this transformation is seen in the paleoecological record of a higher N15 /N13 ratio (indicating a terrestrial source) very early in Chesapeake Bay sediments preceding increased sedimentation. A sudden change from pollen and seeds representing a wet herbaceous flora including ferns, sedges, cattail and burreed to one consisting mainly of dry species such as ragweed, dock, pigweed and grasses occurred at about the same time. Thus a denitrifying environment was quickly changed to one where nitrogen could be leached out of the soil, ultimately reaching the estuary. Although sediment and nutrients from plowing and fertilizing the land were among the ultimate culprits with respect to degradation of the Bay, the first activity leading to eutrophication and ultimately anoxia was the conversion of a predominantly wet land to a dry environment.

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CONSIDERING THE SPATIOTEMPORAL SCALES OVER WHICH CROSS-SYSTEM 'LOAD-RESPONSE' RELATIONSHIPS APPLY IN INDIVIDUAL ESTUARIES

Among the most impactful of Dr. Scott W. Nixon's body of work are his cross-system empirical regressions relating nitrogen load to a number of response variables, including in situ nutrient concentrations, phytoplankton biomass and production, and fisheries landings. These typically robust relationships were rooted in observational studies across a wide range of marine ecosystems and validated with the classic results from the Marine Ecosystems Research Laboratory nutrient gradient experiment in the early 1980s. These relationships contributed not only to our heuristic understanding of coastal ecosystem function, but also formed a basis for management of nutrient loading and predicting response to load reductions. While these and similar relationships by other investigators are based on cross-system regressions, typically using data from one or a few years at a variable number of stations, a fundamental question remains as to how robust they are within individual systems and over multiple years characterized by interannual variability in ecosystem forcing. I will present 'Nixonesque' regressions of load vs. response for the Chesapeake Bay at the scale of the entire ecosystem, within particular sub-regions and sub-estuaries, and at individual stations, using Chesapeake Bay Program monitoring data from 1985 to the present, and supplemented with long-term datasets from other systems. While results at the baywide scale exhibit the typical dose-response relationship for dissolved inorganic nitrogen, they are much less clear for chlorophyll-a. However, when limiting the spatial extent of the analysis to particular regions and stations, the classic relationships begin to re-emerge. Results confirm the utility of the cross-system synthetic regressions within individual systems, but highlight the importance of considering spatial scale when using the regressions to predict responses to interannual variations in load.

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MORPHOLOGICAL CHANGES AND SEDIMENT CAPTURE POTENTIAL OF *ZIZANIA AQUATICA* UNDER EXPERIMENTAL INUNDATION TREATMENTS

Data documenting the effect of sea level rise on tidal freshwater marshes are scarce. Studies in salt marsh ecosystems have proposed that a dynamic equilibrium between vegetation and sediment capture enables many marsh platforms to respond and adjust to current rates of rise. However, these hypotheses have not been tested in freshwater tidal ecosystems. Here we present results from experiments manipulating inundation regimes for an important tidal freshwater annual grass species, *Zizania aquatica*. Tested hypotheses focus on the plasticity of *Z. aquatica* resource allocation to stems, and the feedbacks of these changes on sediment capture. *Zizania aquatica* responded to inundation treatments with morphological changes, such as increased height and stem thickness under increasing inundation. This work will begin to test whether conceptual models regarding the plasticity of vegetation and accompanying sediment capture measured in salt marshes apply to freshwater communities.

Additionally, our work will provide a risk assessment of *Z. aquatica*, related to future inundation regimes, which can be extrapolated to other tidal freshwater wetland sites experiencing sea level rise.

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SELECTION OF ESTUARINE FEEDING HABITATS BY SNOWY AND GREAT EGRETS IN THE PLUM ISLAND SOUND ESTUARY, NORTHEASTERN MASSACHUSETTS

Snowy and Great Egrets are common summer inhabitants of the Plum Island Sound estuary in northeastern, MA, which is part of the largest salt marsh-estuarine system in New England. Almost all the egrets using the Sound nest on offshore islands approximately 15 km away, indicating that the ability to feed in the Sound is a key component of their nesting success. We are examining the selection of particular habitats (e.g., pannes, creeks, vegetated marsh platform) in relation to the tidal cycle of these egrets in the estuary. This research is a component of higher trophic level studies of the Plum Island Ecosystems Long Term Ecological Research program. Our interest is in determining whether the birds consistently prefer certain feeding areas at particular times during the daily or monthly tidal cycle and, if so, what the geomorphic characteristics of these "hot spots" are. Observers have been carrying out surveys of egrets (and other waders and shorebirds) from 45 observation points around the Sound at approximately two week intervals during the field seasons. Results from 2012 and 2013 indicate that feeding by both egret species tend to be concentrated in particular pannes and tidal creeks at low and mid tides, but these patches of high feeding intensity vary both spatially and temporally. The location of any particular low tide hot spot changes with the monthly tidal cycle, precipitation events, and prey depletion. During high tides great egrets in particular feed on the flooded marsh platform. In sum, egrets are opportunistic feeders whose exact feeding locations at Plum Island Sound vary from day to day. Ultimately, we hope to gain insights into how sea level rise might affect bird use of the Plum Island Sound region.

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USING BIOMASS MODELS TO IDENTIFY SITES FOR RESTORATION OF EELGRASS (*ZOSTERA MARINA*) IN PUGET SOUND

The Puget Sound Partnership has identified a goal of increasing the area of eelgrass (Zostera marina) in Puget Sound by 20% by 2020. One of several tools we are developing for locating potential restoration sites is a biomass model that predicts above and belowground growth based upon inputs of light, temperature, and salinity. We are building upon a model developed for a tropical seagrass then adapted to Z. marina by the US EPA Western Ecology Division. We made further adaptations to suit the model for Puget Sound. We used data on the effects of light, temperature, and salinity on photosynthesis and respiration from experiments in Sequim Bay and our laboratory to determine the functional forms and parameters for these relationships. To predict the potential for eelgrass growth throughout Puget Sound, we used output from a 3D Puget Sound hydrodynamic model to provide water elevation, temperature, and salinity. Data on turbidity are scarce; we used marine water quality monitoring data as available to characterize light attenuation values for regions with particular water quality characteristics. We found that model predictions were improved by using region-specific metabolic functions and parameters. When used as an index of habitat suitability, the model predicts eelgrass cover reasonably in some areas of Puget Sound (e.g. river deltas, Northern Puget Sound) and less well in others (South Sound, parts of Central Puget Sound). While we can use GIS post-processing to filter areas known to be unsuitable for factors not included in our model, the model would benefit from additional data, including physiological data over a broader range of environmental conditions, subpopulations, and seasons. In addition, improved information on light attenuation is necessary for spatially and temporally comprehensive predictions in areas as complex and variable as Puget Sound. The model results were used to locate sites for test plantings towards identifying restoration sites.

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SPARTINA IN BRITISH COLUMBIA-CHALLENGES, PARTNERSHIPS, AND PROGRESS TO DATE

Over that last 30 years, three non-native Spartina species have invaded southwestern British Columbia: Spartina anglica in the Vancouver Lower Mainland, S. densiflora on the east coast of Vancouver Island, and S. patens in both locations. While some organizations recognized the negative impact of Spartina on estuarine habitat, many challenges have limited a comprehensive and timely response to control and eradicate these infestations. Some of the key challenges included lack of a single agency mandated to respond to Spartina infestations, lack of funding and capacity, herbicide was not legally available as a control option, and general opposition to herbicide use in the marine environment. Beginning in 2004, partnerships were developed at both local and international scales, to mitigate and provide alternatives to these challenges. A local partnership, the BC Spartina Working Group (BCSWG), was formed to begin mapping and mechanical removal of Spartina infestations. This partnership improved its capacity for Spartina control by working with Washington State agencies and collaborating on a a one year Spartina drift card project. Recent GIS-based mapping and monitoring has demonstrated that the continued under funding of the mechanical control program has failed to contain the Spartina infestations. Therefore a small working group under the BCSWG began investigating the regulatory requirements, treatment methodology, and program costs and benefits of the use of herbicide. In 2013, a Canadian federal emergency registration permit was approved for the use of herbicide on the Spartina infestations in BC. An application is now with the Province of British Columbia for a permit to use both imazapyr and glyphosate on Spartina anglica infestations. The plan is for herbicide treatments to be used in conjunction with manual removal efforts as part of an integrated pest management program aimed at complete Spartina eradication.

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SEASONAL GROWTH OF TWO SEAGRASSES WITH OVERLAPPING DISTRIBUTION IN THE PACIFIC NORTHWEST: THE NON-NATIVE EELGRASS, *ZOSTERA JAPONICA* AND THE NATIVE EELGRASS, *ZOSTERA MARINA*

The non-native eelgrass, Zostera japonica, is expanding its range in the Pacific Northwest and is increasingly found intermixed with the native eelgrass, Z. marina. We investigated the seasonal pattern of growth of these two species in intermixed and mono-specific stands in Padilla Bay, Washington. The native eelgrass, Z. marina, grows on extensive intertidal and subtidal flats in Padilla Bay, Washington covering more than 3000 hectares, about 63% of the intertidal area of the bay. The non-native eelgrass, Z. japonica, was unintentionally introduced to the Pacific Northwest in the early- to mid-1900's. Z. japonica initially became established in Padilla Bay on high intertidal flats that had been bare of macro-vegetation. Mapping of submerged aquatic vegetation over the last 20 years, indicates that Z. japonica has expanded its range in Padilla Bay and is increasingly found intermixed with Z. marina. We measured vegetative characteristics monthly in more than 50 permanent plots—divided into predetermined vegetation cover zones—along a 4.3 km transect from shore to -2.6 m below MLLW. We found the two eelgrass species growing intermingled for more than 1 km along the transect. In the intermingled zones, density of Z. japonica was generally greater than Z. marina and height of Z. marina was greater than Z. japonica. Over the calendar year density of Z. marina was highest in January and decreased through the year while canopy height increased to a maximum in September/October. Density and canopy height of Z. japonica peaked in August. Biomass of both species peaked in July/August in all zones along the transect. Both species grew perennially with above and below ground biomass present throughout the year.

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THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM SENTINEL SITES PROGRAM: MONITORING EFFECTS OF CHANGING WATER LEVELS ON COASTAL VEGETATION WHILE BALANCING LOCAL REQUIREMENTS WITH THE NEED FOR INTEROPERABILITY AND DATA COMPARABILITY ACROSS A HIGHLY DIVERSE SYSTEM OF RESERVES

The National Estuarine Research Reserve System Sentinel Sites Program (NERRS SSP) was established to monitor the effects of sea level change and inundation patterns on emergent marsh, mangrove, and SAV. The NERRS SSP is a foundational program for the NOAA Sentinel Sites Program, which establishes a framework for coordinating multi-agency local and regional science and implementation efforts based on sentinel data. The NERRS SSP began as part of the NERRS Strategic Planning Process and developed through the individual efforts of reserves that added infrastructure and built capacity over the past several years. This presentation will focus on the lessons learned as protocols and procedures were developed to balance the unique requirements of the 28 reserves, located across a suite of highly diverse coastal ecosystems, with the need for interoperability and comparability across the NERRS. To accomplish these goals, standardized protocols were developed to determine current distributions of vegetation communities with respect to elevation and tidal datums and to monitor changes in these relationships. These protocols included highly accurate local vertical control networks connecting local water level observations and measurements of plant community composition and species distributions over elevation gradients. This information can be used to understand the sensitivity of the vegetated communities to interannual variability and long term changes in local water levels and inundation patterns, as well as the response of the surface elevation of these habitats to episodic inundation events. These protocols and the lessons learned in installation of monitoring infrastructure in highly dynamic habitats where transition zones between marsh and mangrove are rapidly changing will be valuable in informing restoration efforts and measures of restoration success in these habitats.

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IMPROVING UNDERGRADUATE ENGAGEMENT IN RESEARCH THROUGH A RESEARCH INTENSIVE MODULE IN A MARINE ECOLOGY COURSE

Research is increasingly becoming a component of undergraduate education; however, research components are often not fully integrated into courses, rather they form a discrete unit within a much larger program. The objectives of this program were to: (1) scaffold research planning and write up skills into the course structure, (2) provide a realistic intensive research experience for undergraduate students, (3) enhance the quality of the research conducted, and (4) increase student socialization into the research environment. This program was evaluated within an undergraduate biology course (3rd and 4th year students) that contains a 10-day research field trip. The program was successful in preparing students for group research projects, as compared to previous years in the same course. Survey results indicate that students gained a greater understanding of the research process and were able to apply those skills to a subsequent research project. The students produced high quality research outputs. After two semesters of running this program seven of the ten projects have produced publishable quality outcomes. Additionally, the research experience taught the students general skills such as problem solving and working with groups. These skills are universally beneficial to students, regardless of their career trajectory. This program has been adapted into a series of online modules applicable across the sciences.

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PREDICTING CHANGES IN MACROPHYTE COMMUNITY COMPOSITION FOLLOWING A FLOOD DISTURBANCE

Floods are a common disturbance in subtropical ecosystems. Floodwaters decrease salinity, increase nutrient load, and decrease benthic light availability. Benthic habitats such as seagrasses and macroalgae are influenced by changes in environmental conditions, potentially resulting in large-scale changes in community composition. We conducted a series of experiments to quantify the effects of flood intensity on two seagrass species (Zostera muelleri and Halophila ovalis) and a macroalga (Caulerpa taxifolia), which form the dominant marine habitat types in Moreton Bay. Z. muelleri declined in both shoot density and aboveground biomass under high intensity flood conditions; however, it remained stable under low to moderate flood conditions. H. ovalis had a significant decrease in above- and belowground biomass under moderate to high intensity flood conditions. Z. muelleri did not recover following the simulated high intensity flood disturbances; however, H. ovalis exhibited rapid (within two weeks) recovery from low to moderate flood conditions. The macroalga C. taxifolia had 100% mortality under high intensity flood conditions and a significant decline in biomass under moderate flood conditions. C. taxifolia populations had a moderate increase under low intensity flood conditions, suggesting they may benefit from increased nutrient loads. These results suggest that under moderate to high flood conditions slower growing species (i.e. Z. muelleri) will exhibit signs of stress and sustain some level of decline; however, faster growing species (H. ovalis and C. taxifolia) will decline dramatically in the same conditions. H. ovalis is likely to recover quickly and therefore increase under moderate to high intensity disturbances.

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OPEN INQUIRY IN A NON-TRADITIONAL UNDERGRADUATE COURSE EXTENDS THE CLASSROOM INTO THE FIELD AND LAB

Inquiry-based learning is a pedagogical strategy designed to encourage students to learn through direct experience in the scientific process. In an open inquiry situation, students formulate their own research questions, design methods to test their questions, and explain their results within the context of the greater knowledge base. The advanced undergraduate class, Diseases and Parasites of Aquatic Organisms, has a companion laboratory that uses an open inquiry format for mentoring undergraduate research in marine biology. Student participants in the lecture and lab courses spend 10 – 12 weeks during the regular academic semester designing group (3 – 4 students) projects that either address their own questions in a novel system, or build on preexisting datasets of parasite ecology or behavior. Examples of this approach have yielded student-collected data on a bivalve-trematode parasitism unmentioned in the literature since the 1950s, a novel decapod-nematode commensal system, physiological and behavioral impacts of an arthropod-arthropod symbiosis, GIS-based assessment of behavioral manipulation in trematode-infected intertidal snails, and fitness effects of an undescribed microphallid trematode in sand crab hosts. Students complete their projects by presenting results in a formal poster symposium attended by members of the institutional academic community. Student projects begun in this class have been expanded into master's degree projects, year-long independent studies, regional and national conference presentations, and preliminary data for grant proposals. Feedback from student researchers indicates that this experience is often one of the most academically impactful of their undergraduate careers.

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DEVELOPMENT OF A COLLABORATIVE TOOL FOR IDENTIFICATION OF FECAL BACTERIA SOURCES IN COASTAL WATERS

The Grand Strand comprises the beachfront communities of northeastern SC and annually hosts 14 million visitors. This region's tourism-based economy relies on coastal water quality being adequate to support recreation, fishing and shellfish harvesting. These uses are compromised by widespread, chronic contraventions of water quality standards for fecal indicator bacteria (FIB). To restore water quality, the Federal Clean Water Act requires development and implementation of total maximum daily loads (TMDLs). Effective TMDLs require knowledge of FIB sources in time and space. These can be determined from watershed-based investigations. Also needed is identification of host animal sources. Recent improvements in host animal source tracers include qPCR assays and chemicals specific for humans, such as caffeine and optical brighteners. These tools are at a transitional stage in their utility and accessibility to coastal managers. By partnering with a local university, the beachfront municipalities have developed local capacity to conduct watershed-based, multi-tracer FIB source tracking investigations. The investigatory protocol relies on close collaboration with local stormwater managers to select sampling sites using their GIS datalayers of stormwater infrastructure and land use/land cover. The university has adapted peer-reviewed research approaches into tools that have been validated in local settings.

It now serves as a local resource for deploying these tools. Validation work included assessment of the current limitations of these new technologies. To address these limitations, a weight-of-evidence approach was adopted based on multiple tracers. Results are conveyed using indices and GIS maps. This protocol was piloted in the largest drainage basin of the City of Myrtle Beach which terminates in the tidal creek system called Withers Swash. The city's stormwater manager authored a Watershed Assessment Report that contains restoration plans.

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DOES ELEVATED CARBON DIOXIDE LIMIT CRUSTACEAN ACCLIMATION TO HYPOXIA?

The incidence of hypoxia (H) in coastal waters has increased dramatically world-wide due to growth in human populations, causing adverse impacts to many estuarine organisms. In estuaries of the southeastern U.S., high CO_2 (hypercapnia) co-occurs with hypoxia causing acidification. We have studied the effects of hypercapnic hypoxia (HH) on the molecular physiology and performance of highly active crustaceans. Exposure to H for 24 hours triggers a change in the transcriptional profile of the hepatopancreas in the Pacific whiteleg shrimp consistent with strategic acclimation to hypoxia by lowering ATP utilization and O_2 demand, including changes in transcripts associated with mitochondrial bioenergetics, protein folding, degradation and synthesis. However, for 75% of the genes most important in distinguishing normoxia, H and HH treatment groups, concurrent exposure to hypercapnia for 24 hours reduces or reverses the transcriptional response to H alone, suggesting either that high CO_2/low pH interferes with transcriptionally-based acclimation to hypoxia or elicits physiological or biochemical responses that relieve internal H. Exposure to H for 24 hours reduces the rates of protein synthesis in shrimp muscle and hepatopancreas, as measured by the flooding dose technique. The impact of 24 h exposure to HH on protein synthesis rates is more severe than H alone, indicating that high CO_2/low pH aggravates at least one short term manifestation of acclimation to hypoxia via metabolic depression. More recent experiments evaluating performance in the Atlantic blue crab show that their ability to walk on an underwater treadmill decreases in H, with fatigue being reached more quickly as the level of hypoxia intensifies. Hypercapnia in moderate hypoxia does not have a deleterious influence on behavior and lengthens slightly the time it takes crabs to fatigue. These studies point to complex effects of high CO_2/low pH on hypoxia acclimation in crustaceans (NSF-IOS 0725245).

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UNDERGRADUATE RESEARCH AND COMMUNICATION EXPERIENCES IN MARINE BIOLOGY AT FORT JOHNSON, SC

Since 1992, the Fort Johnson Undergraduate Summer Research Program has offered 10-week laboratory-based research internships in marine biology for 178 students from across the US. Led by the College of Charleston's Grice Marine Laboratory and funded by the NSF since 1999, the Program aims to recruit a diverse group of students to careers in STEM. The Program also draws mentors from non-traditional entities including the SC Dept. of Natural Resources, National Ocean Service (NOAA), National Institute of Standards and Technology, and Medical University of SC. Core elements of the Program have remained constant, attracting many talented applicants who have limited opportunities to explore careers in marine biology or to conduct independent research. Across all years, 88% of Program alumni tracked into STEM-related careers. Participating scientists enjoy the role of mentor despite the intense, strictly voluntary effort. Each summer the interns produce high-quality data, evidenced by 29 peer-reviewed publications to date. In contrast, strategies to achieve a cohort experience are constantly changing. Recent events point to the need for scientists to be enthusiastic and capable communicators who are comfortable in the face of public, professional as well as congressional scrutiny. Over the past three summers, interns have engaged in a series of "communicating science" activities in parallel with their independent research projects. Interns are challenged to explain their work and its importance to a variety of audiences, starting with their families, then to middle school students, policymakers and the public. In addition to standard professional outcomes, such as oral presentations and scientific manuscripts, Program interns produce press releases, "elevator speeches," a middle school lesson plan and public display. Assessment of these communication activities in achieving the central goals of the Summer Program is in progress (NSF DBI-1062990).

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A LABVIEW-BASED AUTOMATED CONTROL SYSTEM FOR FLOW-THROUGH DIEL-CYCLING HYPOXIA AND PH EXPERIMENTS, AND OVERVIEW OF EFFECTS ON THE EASTERN OYSTER

Flow-through raw seawater systems are notoriously problematic for experimental manipulations of dissolved oxygen and pH, and as such, are rarely effective. We successfully developed a LabVIEW-based system capable of monitoring and controlling co-varying diel-cycling fluctuations in DO and pH in flow-through aquaria housing Crassostrea virginica. Using a constant total gas flow rate, our system controls ratios of nitrogen, oxygen, carbon dioxide, atmospheric air and CO2-stripped air to achieve target DO & pH values on a diel cycle. Conditions are constantly recorded using Oxyguard DO probes, Honeywell ISFET Durafet III pH sensors, an Instrumentation Northwest conductivity/temperature probe, and a Global Water barometric pressure transistor. Measurements of in-tank pCO2 are achieved by equilibration and measured using Licor840A CO2 gas analyzers. Alkalinity is determined during thrice weekly 2-point titrations, and CO2SYS is used to cross-check measured parameters. The system has the capacity to control 5 treatments with DO and pH target values in increments from 1min to 24hrs. Our control system was successfully employed in 4 long-term flow-through estuarine experiments investigating effects of diel-cycling hypoxia and pH on Crassostrea virginica survival, growth, fecundity, Perkinsus marinus (Dermo) disease progression and immune response, and proved to work extremely well, even under flow-through conditions. In our 2012 experiment the normoxic treatments had a mean daily DO of 7.25mgL-1 +/-0.018(SE), the moderate treatment had a mean daily minimum DO of 1.69mgL-1 +/-0.001, and the severe hypoxia treatments had a mean daily low DO of 0.56 mgL-1 +/-0.01. The pH values of non-cycling pH treatments had a daily mean pH value of 7.81 +/-0.01, and cycling low pH treatments had a daily mean low pH of 7.01 +/-0.003. Our goal for 2013 experiments was to lower our pCO2 levels in our normoxic/normcapnic treatment substantially below that of our incoming seawater.

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OTOLITH STRONTIUM ISOTOPE LIFE HISTORY RECONSTRUCTIONS OF DELTA SMELT, *HYPOMESUS TRANSPACIFICUS*

The USFWS Biological Opinion identified increased fall freshwater outflow as one of the Reasonable and Prudent Alternatives to protect delta smelt from extinction. In the fall of 2011 freshwater outflow in the fall serendipitously meet this criteria and multiple investigators from State, Federal Agencies and the University of California Davis set out to study the impacts of increased fall outflow on the Low-Salinity Habitat of the upper estuary. In collaboration with Interagency Ecological Program (IEP) long-term fish monitoring surveys, this study examined the strontium isotope ratios to assess the life history variability and adult salinity habitats for fish collected in 2005, 2006, 2010 and 2011. Otolith strontium isotope ratios from birth to death identified several different migratory life history types, including year-round freshwater resident fish, early and late migrating fish and fish that reared in brackish water for their entire life. Patterns appeared to vary between the study years, but due to small sample sizes in 2005-06 and 2010 patterns were obscure. In 2011 we sampled 297 individuals and observed distinct patterns in migration timing, with a two modes of migration out of the lower Sacramento River; one around 30 days old and another between 60-90 days old irrespective of birthday, suggesting behavior control of their migration out of freshwater. The transition to salinities greater than 2ppt however exhibit a more uni-modal distribution suggesting early migrating fish resided in very low salinity waters until a size or age was reached at which higher salinities could be tolerated. Adult salinity history varied considerably among the study years, with 2011 exhibiting the lowest overall adult salinity history, while 2006 had the highest salinity history, although making broad conclusions about previous years may be obscured by the small sample sizes.

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DEVELOPMENT OF A THEORETICAL BASIS FOR MODELING DISEASE PROCESSES IN MARINE INVERTEBRATES

Understanding the initiation and termination of epizootics in marine invertebrate populations requires the development of a theoretical framework for disease transmission in marine systems. This talk outlines a cross-disciplinary research project designed to expand the general framework for modeling infectious diseases in terrestrial systems to marine and estuarine systems, using Dermo disease in eastern oysters (Crassostrea virginica) as an experimental system. The first objective of this project addresses how pathogens are dispersed between sedentary invertebrate hosts, including how hydrodynamic and biological processes maintain disease transmission. The interaction between host population density and filtration capacity makes it possible for host populations to affect environmental concentrations of pathogens, and the second objective addresses how the density of hosts can affect the local dose of a disease agent through filter-feeding. As host populations reduce concentrations of pathogens in the environment, epizootics become sustained on individuals within the population most susceptible to infection. The third objective addresses the genetic basis for within-population susceptibility to infection, and its role in sustaining epizootics of marine diseases. The long-term studies of the Delaware Bay oyster population provide the foundation for addressing these three objectives.

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NUTRIENT DYNAMICS IN THE MISSION-ARANSAS ESTUARY: IMPACTS ON PHYTOPLANKTON BIOMASS, GROSS PRIMARY PRODUCTION AND NET ECOSYSTEM METABOLISM

The Mission-Aransas Estuary is a relatively pristine estuary in arid south Texas with low freshwater inflows for extended periods punctuated by periods of high freshwater inflow that introduce major pulses of nutrients and organic matter into the system. Five permanent monitoring stations provide high temporal resolution hydrographic data at these sites that allow calculation of daily rates of gross primary production (GPP), community respiration (CR) and net ecosystem production (NEP). In spite of large changes in nutrient loading during periods of low and high inflow, high rates of GPP were maintained. Based on these measures, and experimentally measured nitrogen transformation rates in the water column and sediments, it is apparent that the estuary switched from a net sink for N during high inflow periods due to increased rates of denitrification, to a net source for N during droughts due to increased rates of N fixation and internal N cycling. Chlorophyll concentrations measured with high temporal resolution at our monitoring stations indicate a temporary increase in phytoplankton biomass following inflow events. To improve understanding of the responses of the estuary to nutrient pulses, we have built an along-track data collecting system to collect high spatial resolution data during our bimonthly trips to service monitoring platforms. Results of these studies in an estuary with limited anthropogenic impacts will aid in the establishment of numerical nutrient criteria for Texas estuaries.

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REMOTE SENSING-BASED ESTIMATES OF PLANT BIOMASS AND NITROGEN CONTENT TO ASSESS COASTAL WETLAND SUSTAINABILITY

There is a growing need to quantify large-scale carbon sequestration rates in coastal wetlands to better understand marsh resilience to sea level rise and to help define eligibility for carbon offset credits. To address this need, we developed methods to estimate aboveground plant biomass and foliar nitrogen concentration over a large spatial extent with remote sensing data, and we tested how accuracies and errors vary with sensor spatial and spectral resolution. Over the 2011 and 2012 growing season, we collected aboveground biomass and leaf nitrogen data on hardstem bulrush (Schoenoplectus acutus) and cattail (Typha spp.), and coupled them with reflectance data from a field spectrometer (350-2500 nm) at a USGS experimental site and a second newly restored peatland in the Sacramento-San Joaquin River Delta. We analyzed reflectance data to develop vegetation indices that predict biomass and leaf nitrogen concentration and that account for season and background effects of water inundation, litter and floating aquatic vegetation. We simulated 164 hyperspectral Hyperion bands, eight Digital Globe World View-2 bands, and six Landsat 7 bands with the field spectrometer data and calculated multiple new vegetation indices using all band combinations. We tested whether biomass estimation improves by including leaf height above the water surface in a regression model. The Hyperion data produced the best biomass and nitrogen estimates compared to Landsat and World View-2 data. The addition of leaf height in a regression improves biomass estimates, with R2 = 0.62 compared to R2 = 0.48 for a mid-summer dataset. Remote sensing-based estimates of plant characteristics combined with environmental covariables will help predict belowground plant productivity over large extents. Results can be used to assess imagery requirements for large-scale monitoring of wetland resilience and restoration success.

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SECONDARY PRODUCTION – A FUNCTIONAL APPROACH TO ASSESS THE CONDITION OF MACROBENTHIC COMMUNITIES

The management, restoration and/or protection of marine, coastal and estuarine ecosystems require more functional metrics than typically available from traditional environmental monitoring programs. Ecosystem functional metrics such as rates of primary productivity, secondary productivity, trophic level transfer to commercially and recreationally important fish and shellfish are essential surrogates for estimating energy flow. Parameters that assess ecosystem structure are widely used, diverse, and often profligate. Parameters that assess ecosystem function should be less variable and better understood in directing ecosystem management decisions. Thus assessment of benthic secondary productivity estimates as a management assessment tool deserves serious further consideration, development as a tool and application in management decisions. We have applied an empirical model for estimating secondary productivity in infaunal macrobenthic communities of the Chesapeake Bay. Utilizing data from a long-term monitoring program initiated in 1984, we compare and contrast results derived from traditional metrics of community health to those of secondary productivity.

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THE CONTRIBUTION OF PHYTOPLANKTON PRODUCTION TO SYSTEM METABOLISM IN APALACHICOLA BAY, FLORIDA

Upstream diversion of freshwater from the Apalachicola River is a primary management concern in the watershed because of the potential negative impacts on the estuarine community including an important commercial oyster fishery. Average annual primary production in Apalachicola Bay, FL over a 15 year period is 401 gC m-2 y-1. Primary production calculated using oxygen data from data sondes using Odum's open water method is higher than previous measurements of phytoplankton production. Interannual variability in primary productivity or respiration is relatively low compared to high interannual variability in salinity or to the strong seasonal patterns in production and respiration. Ten

years of chlorophyll, light, and PAR data were used to estimate phytoplankton production using Cloern's BZI model. The magnitude of this estimated phytoplankton production is similar to total system production. We compare these two different estimates to examine the importance of phytoplankton production to total system production, and the role of seasonal and interannual changes in freshwater flow, salinity, light and nutrients.

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STUDY OF MEIOFAUNA IN ZHANJIANG MANGROVE IN GUANGDONG, CHINA

Abstract: Zhanjiang Mangrove National Nature Reserve in Guangdong, China was chosen as our research area. Meiofauna was investigated seasonally in 2010 with respect to composition, abundance, biomass and diversity in four different floristic biotopes. A total of 11 groups of meiofauna were identified. These were Nematoda, Oligochaeta, Copepoda, Polychaeta, Ostracoda, Kinorhyncha, Halacaroidea, Foraminifera, Tanaidacea, Turbellaria and Amphipoda. Free-living marine nematodes were the most dominant group, accounting for 96.14% of the total abundance of meiofauna; the second dominant group is Oligochaeta, accounting for 2.21%. The average abundance of meiofauna was 856.1 ind.10cm-2. The highest abundance of meiofauna was in autumn, followed by spring, and the abundance in winter was the lowest; the average biomass of meiofauna was 703.8 µg.dwt.10cm-2, the highest biomass of meiofauna was in spring, followed by autumn, and the biomass in summer was the lowest. Sonneratia apetala biotope had the highest abundance and biomass. A total of 78 free-living marine nematode species were identified in spring and summer. The dominant species are Terschellingia longicaudata, Polysigma sp., Haliplectus sp.1, Spilophorella sp.1, Sabatieria sp., Spilophorella sp.2, Hopperia sp., Terschellingia sp.2, Anoplostoma sp., Trissonchulus sp., Terschellingia sp.5, Subsphaerolaimus sp., Astomonema sp.2, Astomonema sp.1 and Parasphaerolaimus sp., the above 15 species accounted for 86.80% of total dominance. There are significant differences of nematode community structure among different mangrove biotopes and Sporobolus virginicus.
Keywords: Mangrove; Meiofauna; free-living marine nematodes; benthic community ecology; biomass.

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MINERAL VS. ORGANIC CONTRIBUTION TO MARSH ELEVATION IN RESTORED MARSHES (EBRO DELTA, SPAIN)

The Ebro Delta (Catalonia, Spain) is one of the most valuable coastal zones within the Mediterranean Sea, supporting a highly productive rice agricultural system, as well as a myriad of coastal marsh habitats. However, chronic reductions of fluvial sediments coupled with accelerated relative sea level rise (RSLR) have created an environment where approximately half of the Ebro Delta is now vulnerable to flooding. To assess RSLR mitigation using marsh restoration within abandoned deltaic rice fields, we established an experimental-field study over 3 years. We used two freshwater types (riverine irrigation and rice field drainage water) and three water levels (10, 20 and 30 cm deep). Our hypotheses were that vertical accretion (VA) and elevation change (EC) in oligohaline restored marshes would be primarily controlled by organic contribution, and both would have higher rates than predicted RSLR in Ebro Delta (5-8 mm yr-1) under current low sediment availability conditions. VA (but not EC) was significantly higher in drainage water treatments receiving significantly higher sediment input and had higher mean values in both water types (11.5 and 15.5 mm yr-1) than elevation change (9.1 and 8.8 mm yr-1). However, experimental units with significantly higher belowground biomass had higher EC (11.3 and 17.8 mm yr-1) than VA (8.3 and 15.1 mm yr-1) in both water types due to high weed colonization by Paspalum distichum. These results showed that mineral contribution was generally higher than organic contribution to VA and EC, although P. distichum highly promoted elevation gain by root growth. The results supported the hypothesis that oligohaline restored marshes often had elevation gains higher than predicted RSLR at least during the initial marsh development. This study indicates that the use of agricultural runoff as primary source of sediment, nutrient, and freshwater is beneficial for marsh restoration projects focused on mitigating RSLR and other climate change impacts.

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INTRODUCING FLOW MODELING AT A YOUNGER AGE - A VIDEO FOR NUMERICAL MODELING CONCEPTS IN HIGH SCHOOL

The application of numerical models to study physical processes in the oceans and estuaries is not new to oceanographers, but it is unfamiliar to many high school aged students. The objective of this project is to introduce numerical modeling of estuaries to high school students in physical science classes. The project includes an instructional video, which explains complex physical forces that play a part in fluid modeling. Among these concepts are the forces caused by the shape of the estuary and the density difference between brackish and fresh water. The video uses animation and real-time videography to help explain the changing currents in our realistic numerical model of Yaquina Bay estuary, in Newport, Oregon. After the video is developed, it will be sent to participating high schools where learning will be assessed by the ability of students to identify and explain modeling concepts and estuary dynamics such as uses and development considerations of mathematical models. The success of the video will be evaluated by questionnaires, taken by students before and after the video is seen. The video will meet national science education content standards including unifying concepts, science and technology, physical science, and science as inquiry.

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PRELIMINARY TRANSCRIPTOME ANALYSIS OF A SEAGRASS TOWARD THE DEVELOPMENT OF FUNCTIONAL GENOMIC TOOLS

Seagrass meadows are productive ecosystems whose global decline points to a need to better understand how the plants respond to anthropogenic stressors. Biomass-based seagrass measures are "lagging indicators" of seagrass status. We seek to develop functional genomic tools to identify and quantify how seagrasses respond to various stressors, potentially identifying a set of "leading indicators" of stress. There are no assembled genomes for Gulf of Mexico species of seagrass and little sequence data for *Halodule wrightii*, however a transcriptomics approach can be used to directly identify gene coding sequences and to characterize gene expression changes with sufficient depth of sequencing (RNAseq). We applied 454 pyrosequencing to *H. wrightii* cDNA, obtained from leaf tissue at night, to generate a partial transcriptome resource that will initiate the discovery and annotation of novel stress response genes and pathways. Sequencing produced 256,208 reads, comprising 73.9 Mb, that assembled into 1,790 large contigs (> 500 bp; avg. 813 bp). BlastX hits were obtained for ~97% of the contigs and over 10% had stress-related annotations. An additional 550 small contigs (200-500 bp) with gene annotations were identified. The identified gene sequences can be used to design PCR primers to enable testing of specific hypotheses regarding gene expression changes. These genomic indicators will offer an alternative perspective on the assessment of seagrass status and stress. Additional sequencing will more fully characterize the *H. wrightii* genome to provide a reference sequence useful for the RNAseq approach.

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A MARINE MICROBIOME APPLICATION FOR THE UNDERGRADUATE MOLECULAR BIOLOGY LABORATORY

A marine microbiome-themed research activity is being developed as the focal point of the Molecular Biology course laboratory component at TAMU-CC. A primary objective is to bridge the gap and mutually broaden the knowledge of our two main types of undergraduate biology majors: marine biology track and biomedical sciences/molecular track. An important goal is for the students to acquire significant hands-on research and biotechnology skills to prepare them for either field, and to appreciate and creatively develop new applications of this technology. After initial skills development, the 8 wk microbiome project characterizes a seagrass epiphyte biofilm using a 16S rRNA cloning and sequencing approach, utilizing a grant-supported Beckman CEQ 8800 sequencer and Typhoon 9410 fluorescence imaging system. Microbiome bacteria (25 clones/group) are characterized and presented to make connections between microbial and seagrass ecology and biochemistry. Commercial kits and manufacturers' instructions are used rather than a single in-house laboratory protocol. Students are challenged to develop applications for biofuels, environmental monitoring and healthcare. Anecdotal evidence suggests that this experience contributes positively to

student competitiveness in post-graduation endeavors. We are transitioning to incorporate a genomics module that analyzes public microbiome data. Supported by USDA-NIFA # 2010-38422-21322.

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OCEAN ACIDIFICATION IMPACTS ON SURVIVAL, SIZE, AND CONDITION OF EARLY LIFE STAGES OF WINTER FLOUNDER,*PSEUDOPLEURONECTES AMERICANUS*

Limited evidence to date supports the expectations that effects of elevated levels of CO2 in finfish will differ across species, will be subtle, and will interact with other stressors. CO2 and temperature effects were tested on the embryos and larvae of an ecologically important marine fish, winter flounder (Pseudopleuronectes americanus). Fertilization success and survival to hatch significantly increased with increasing CO2 exposure. In addition, larval survival increased with increasing CO2 at cooler temperatures, however survival decreased with increasing CO2 in warmer temperatures. The mean lengths of larvae were longer at cooler temperatures and higher CO2 levels. Mean protein mass was also greater in more advanced larvae exposed to higher CO2 levels. Preliminary results indicate mortality at earlier ages of smaller, less developed individuals in higher CO2 environments, which may account for the larger mean length and mass calculated for survivors. RNA/DNA measured as a proxy for condition was reduced in young larvae exposed to elevated CO2 levels and especially at colder temperatures. Finally, winter flounder larvae exposed to high CO2 levels showed increased cranial-facial, ocular, and muscular abnormalities, and an increased occurrence of hepatic lesions. In summary, winter flounder gametes and embryos may be relatively tolerant to high levels of CO2 due to their occurrence in variable benthic inshore habitats. In comparison, a previous study found that summer flounder, which spawn in coastal ocean water and therefore experience stable relatively high pH conditions as embryos, showed reduction of embryonic survival with increase CO2 exposure. Finally, while winter flounder embryos may be more tolerant to impacts of ocean acidification, their larvae appear vulnerable to sublethal effects from constant long term exposure to high CO2 levels, as expressed by decreased condition, increased abnormalities and lesions, and lower survivorship to metamorphosis.

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SEA-LEVEL RISE IN LOCAL PLANNING POLICIES: THE CASE OF BACACAY, ALBAY, PHILIPPINES

Low-lying coastal areas in the Philippines are among the most vulnerable to sea-level rise. The exposure to tropical cyclones which are anticipated to become stronger as a result of climate change increases the significant threats posed by sea level rise on these communities. This paper examines the socioeconomic impacts of tropical cyclones and sea-level rise to water resources and settlement in selected coastal communities of the municipality of Bacacay, Albay in the Philippines. Likewise, storm surge, flood, and saltwater intrusion are looked into. The 1.3 meter sea-level rise scenario was used to project impacts for 2100. This scenario was generated from an ensemble of various GCMs in the SIMCLIM modeling system with A1F1 as the chosen storyline. This APN-funded research recommends the need to mainstream climate change adaptation in the barangay (community) and municipal land use and coastal zone development planning and enhance the capacity of local stakeholders to effectively implement local adaptation plans. It also highlights the importance of integrating science with local knowledge to promote more robust climate change assessment and hence effectively tackle climate change challenges at the local level.

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SETTLE DOWN!: CRAB LARVAE SETTLEMENT PREFERENCES IN SHIFTING COASTAL ECOSYSTEMS

When habitats vary in quality, an organism's fitness can depend on habitat selection. Many organisms prefer habitats that optimize survival, especially during early life stages. The migrating post-larval (megalopae) stage of many crab species actively selects settlement habitat, a process which we hypothesize is determined by habitat-specific survival. Survival, in turn, may be driven by the quality of refugia provided by physical habitat structure, so differences in habitat structure should drive differences in preference. Along the southeastern coast of the United States, geographic shifts in structurally distinctive wetland vegetation hold possible implications for crab habitat selection, survival, and fitness. We tested habitat preference and survival of post-larval crab species using live and artificial mangroves and marsh grasses. We expected megalopae to be able to distinguish between live habitats, with species preferring the vegetation type that is most locally abundant within their range. Moreover, we expected structural cues to become more important once predator cues were introduced. To test habitat preference, natural densities of locally abundant crab species were given 12 hours to settle in circular tanks containing multiple habitat sections. Preference was also tested with predator cues present. Experiments were run overnight, during peak megalopae activity. Finally, corresponding habitat-specific survival was tested as crab survival over time in tanks containing a single vegetation type and freely foraging predators. If megalopae habitat preference is driven by survival, then we expected predator cues to strengthen patterns of habitat choice and survival probability to correspond to preference. Testing the choice and survival of megalopae in neighboring dynamic habitats, such as salt marshes and mangroves, allows us to understand the implications of shifts in the distribution and composition of these habitats resulting from global climate change.

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CARBON DYNAMICS AND SEQUESTRATION POTENTIAL IN AN URBANIZING ESTUARY

As coastal development around Australia continues apace, it is important to understand how urbanisation may be affecting carbon fluxes in estuaries and their ongoing health and productivity. As part of the Terrestrial Ecosystem Research Network (TERN) southeast Queensland periurban super site, we have over a number of years made continuous high-frequency measurements of dissolved and inorganic carbon parameters under that provide new insights into the often ephemeral and spatially variable carbon dynamics that result from differing hydrological regimes and landuse practices. Using isotopic, as well as several organic carbon diagnostic methods, we have examined the contribution of allocthonous and autochthonous carbon sources to primary and secondary estuarine production, and evaluated the. We discuss the significance of carbon pools and fluxes along this catchment-coast continuum, demonstrate the value of establishing long-term for carbon research sites as a basis for ongoing, multi-disciplinary research, and its practical application for evaluating carbon sequestration potential in the Logan estuary in the context of ongoing urbanization pressure and restoration initiatives.

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SEDIMENT REMOBILIZATION BY WIND, WAVES, AND CURRENTS DURING METEOROLOGICAL FRONTAL PASSAGES IN A SHALLOW, MICRO-TIDAL BAY

Sediment transport in the bays and estuaries of the Northern Gulf of Mexico can be significantly impacted by episodic meteorological events. This study investigated the impact of cold fronts on the seabed of the shallow (~ 2 m), micro-tidal Galveston Bay located along the Texas coast in the northwestern Gulf of Mexico. Two instrument deployments, which included an Acoustic Doppler Velocimeter (ADV), Acoustic Wave and Current meter (AWAC), CTD with Optical Backscatter Sensor (OBS), and sonar altimeter; collected flow and suspended sediment concentration data during two separate cold front passages. Results show that wind stresses increased as a result of the frontal passage, where wind speed had increased following the shift in wind direction from the south/southeast to the north/northwest. This also resulted in a 2-3 fold increase in near-bottom current speeds, and waves in the bay. Sediment resuspension was induced due to enhanced shear velocities near the bed caused by waves generated in the bay. These results show that sediment resuspension requires wind stresses strong enough, and from the proper direction to generate waves. Therefore sediment remobilization does not occur throughout the frontal passage, but rather at discrete times when the proper conditions persist. Maximum sediment resuspension

observed occurred after the front had passed through the area. During this period an order of magnitude increase in suspended sediment concentrations were measured. In this micro-tidal bay, with a negligible freshwater discharge, where cold fronts impact the area on average 30-40 times a year, the cumulative effect of these events may represent the dominate mechanism for sediment transport in this bay, and similar bays throughout the region.

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STABLE ISOTOPE ANALYSIS OF SALMON SHARK VERTEBRAE REVEALS ONTOGENETIC CHANGES IN HABITAT IN A MIGRATORY SHARK

Studying migratory marine species throughout their ontogeny is often difficult or impossible. Salmon sharks (*Lamna ditropis*) are wide-ranging apex predators in the North Pacific that as adults use neritic habitats extensively, yet virtually nothing is known about trophic ecology and habitat use of young salmon sharks or ontogenetic shifts in their diet and habitat use. We used stable isotope analysis (SIA) of salmon shark vertebrae to elucidate ontogenetic changes in habitat use and trophic ecology. The tissue in each annulus of a salmon shark's vertebra provides an isotopic record that reflects an integrated record of their movements and foraging over a year of their life. By serially sampling vertebral annuli for stable isotope ratios of carbon ($^{13}C/^{12}C$) and nitrogen ($^{15}N/^{14}N$) we reconstructed a general history of habitat use and migration in individual sharks. We utilize an isoscape of the major biogeographic provinces of the eastern North Pacific in conjunction with a Bayesian mixing model to estimate annual patterns of use among ecoregions. Electronic tagging data were used to inform mixing model results by characterizing annual patterns of ecoregion residence of larger sharks. There was a clear ontogenetic shift in habitat where sharks primarily used offshore habitats during their juvenile years, with increasing use of productive neritic habitats with age. Integrating information on movements or distributional patterns with stable isotope data provides a unique and powerful way to study the ecology and life history of migratory marine species.

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NOAA'S SENTINEL SITE PROGRAM'S HAWAIIAN COOPERATIVE-BRINGING COMMUNITIES AND GOVERNMENT TOGETHER TO ADDRESS CLIMATE CHANGE RISKS

In 2011 NOAA created the Sentinel Site Program (SSP), designating 5 regions as pilot locations: Hawai'i, San Francisco Bay, Northern Gulf of Mexico, North Carolina, and the Chesapeake Bay. The goal of the Sentinel Site Program is to improve the management of resources by bringing to bear the full force of NOAA's coastal and ecosystem tools and services in partnership with other federal, state, and local efforts to address the impacts of sea level rise and coastal inundation. The Hawaiian Islands Cooperative is a compilation of sites that includes Midway and French Frigate Shoals in the Papahānaumokuākea Marine National Monument, He'eia on the island of O'ahu, and a portion of the Kona Coast on the Big Island of Hawai'i. NOAA will work to coordinate and focus efforts within each site so the identified topics of emphasis, which includes food security and ecosystem integrity, will be addressed in a manner that improves resource and community management and resilience. The presentation will discuss how the Hawaii cooperative is working, some lessons learned, and how it serves as an example of an innovative initiative that will protect Hawaii's resources, both by improving existing management as well as preparing for the future impacts of climate change. It will discuss some of the needs that have been identified, such as the need for effective monitoring of sea level change which includes the need and challenges of obtaining accurate elevation data.

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COMPARING SALMONID, BENTHIC, AND FORAGE FISH RESPONSE TO RESTORATION AND PREDICTING COMPOSITION OF FISH SPECIES AT PROPOSED RESTORATION SITES

Estuaries represent important rearing habitats for many commercial fish species, including threatened members of the salmonid family. In response to the rapid decline of multiple estuarine dependant species and salmonid species, specifically O. tshawytscha and O. kisutch, numerous efforts have been made to restore crucial estuarine rearing habitat and improve commercial fish stocks. However, these efforts have met with varied success. This meta-analysis strives to unify the estuary restorations on the Pacific Coast and identify common themes in successful restorations in order to improve the quality of future efforts. Ten estuaries and twenty restoration events were analyzed along the western coast of the United States. Studies selected for analysis included reference sites in unaltered estuary areas matched to treatment sites and reported on densities or abundance of fish populations. If physical information like restoration size was missing from the study, this information was retrieved from maps provided by the authors of the study and using Google Earth Pro. Sites were then analyzed as a group, by fish species and fish functional group to show trends in fish abundance based off of restoration size, position proportion, entrance width, and years passed since the initial restoration event. Multiple regression analysis indicated that larger restoration sizes have a positive correlation with salmon treatment and response. Contrasting results were found for other functional groups including benthic species and forage fish. These findings could have impacts on selections for future restoration sites and could shed light on what species compositions would look like at a given site, before restoration takes place. This meta-analysis also demonstrates that monitoring is key to assessing the long-term success of restoration as estuaries may not be restored to full productivity until decades after restoration efforts.

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EFFECTS OF SUBMARINE GROUNDWATER DISCHARGE ON BACTERIAL GROWTH EFFICIENCY IN COASTAL HAWAIIAN WATERS

It is debated whether heterotrophic bacteria are primarily a source or a sink of organic nutrients to marine food webs. Bacterial growth efficiency (BGE) measurements provide insight into the amount of carbon consumed by bacteria, used for biomass production, available for higher trophic levels, and respired. Most BGE studies have focused on river-dominated estuaries; however, submarine groundwater discharge (SGD) can also be an important source of freshwater, nutrients, and organic matter to coastal waters, especially in areas without rivers. Our study examined BGE, as well as the bacterial abundance, growth, production, and respiration in surface waters both inside and outside the influence of SGD at four sites on Hawai'i Island, two on the leeward side (dry) and two on the windward side (wet). BGE and bacterial production both inside and outside the groundwater plumes across all sites were low compared to other tropical and temperate coastal waters. Windward groundwater plumes had the lowest salinities, bacterial abundance, and BGE, but the highest growth rates compared to those on the leeward side. Our results suggest BGE may not accurately reflect the condition of the bacteria, as higher growth rates were associated with low BGE in windward groundwater plumes. The low BGE and bacterial production in these waters appears to be driven by the low bacterial abundance potentially from a washout effect resulting from substantial SGD inputs. Overall, we found that bacteria were a sink for organic nutrients across all sites and that the sink was stronger in areas with higher groundwater input.

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MERGING MODIS TIME SERIES AND SEAGRASS MONITORING DATA FOR WATER QUALITY ASSESSMENT AND SEAGRASS PROTECTION IN FLORIDA'S BIG BEND REGION: SUCCESSES AND LIMITATIONS

Florida's Big Bend coastal region contains the second largest contiguous seagrass bed in the continental US. The Suwannee River drains a largely agricultural watershed (26,000 km2) in Georgia and Florida, and its discharge (x= 280 m3/s) affects water clarity over most of

the Big Bend seagrass beds. This project attempts to improve water quality and to protect Big Bend seagrasses by making remotely sensed optical water quality data more accessible to managers and stakeholders involved in the process of regulating nutrient loads in the Suwannee River and to provide data to assess effectiveness of management actions. To accomplish this goal, we have tested the QAA and EOF algorithms of Lee et al. (2006) and Craig et al. (2012) for retrieval of Kd, chlorophyll, and CDOM from Modis imagery for the period 2003-2012, a task complicated by the high CDOM concentrations in the Suwannee River plume. We have also compared the time series of Modis optical water quality (OWQ) estimates for the Suwannee River Estuary (SRE) to seagrass gains and losses. During two years of bimonthly ground-truth cruises, chlorophyll concentrations, Aph, Ad, and Acdom in the SRE ranged from 0.3-38.3 mgm-3, 0.013-1.056, 0.013-0.735, and 0.042-7.24, respectively. For most locations and most cruises, CDOM was the dominant determinant of Kd. For several large river discharge events between 2002 and 2011, Kd488 estimates (calculated from the QAA of Lee et al. 2006) were strongly correlated with Suwannee River discharge. However, the overall r2 value of the discharge-Kd relationship for the entire period 2002-2011 was only 0.35, possibly as the result of phytoplankton blooms delayed and displaced by high CDOM concentrations. Validation of QAA and EOF algorithms has also been more complicated than expected, and accuracy assessment continues.

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NITROGEN IN BIVALVE SHELL AND SOFT TISSUES: IMPLICATIONS FOR N SEQUESTRATION AND CYCLING IN COASTAL WATERS

We quantified N assimilation into tissues of several bivalve species, linking N to anthropogenic sources for management, and defining timescales of N sequestration or removal that may affect ecosystem functions (particularly biogeochemical cycling). N assimilated into bivalves largely depended on food quantity and quality, which determined growth (rate of N assimilation) and %N content in both soft tissues and shell. N assimilation rates and %N are at least affected by species-specific physiology, feeding habits, ontogeny and genetics, and cannot be generalized due to site-specific variation in food supply and environmental attributes. Similarly, biodeposition that allows N sequestration via burial or biogeochemical processes depended on food quantity and quality as well as environmental variation. Stable isotope analysis linked biological responses to anthropogenic N sources across temporal and spatial scales, even when effects on growth or survival were not measurable. More data are needed to define timescales of sequestration, particularly in older reefs and for deposited shell. Interestingly, in many cases, external N loading appears to have a positive influence on N removal capacity of bivalves by increasing growth rates and N storage in tissues, but external N loaded is greater than enhanced N sequestration and removal capacity, particularly in areas with increasingly limited available habitat. Ultimately these data may be combined from different regions to estimate global losses of N sequestration capacity through time due to bivalve depletion and predict capacity of sequestration or removal through restoration and farming activities.

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STATISTICAL ANALYSIS OF SEDIMENT DYNAMICS IN SHALLOW MICROTIDAL LAGOONS

A precise description of sediment dynamics is crucial when investigating the evolutionary trend of the different morphological structures of tidal landscapes. A mathematical model has been developed which describes sediment entrainment, transport and deposition due to the combined effect of tidal currents and wind waves in shallow lagoons considering both cohesive and non-cohesive sediments. The model was calibrated and tested using both in situ point observations and turbidity maps obtained analyzing satellite images. Once calibrated the model can integrate the high temporal resolution of point observations with the high spatial resolution of remote sensing, overcoming the intrinsic limitation of these two types of observations. The model was therefore run simulating an entire year (2005) which was shown to be a "representative" year for wind and tide characteristics in the Venice Lagoon. The time evolution of the computed total bottom shear stresses and suspended sediment concentration was analyzed on the basis of a "Peaks Over Threshold" method once a critical value for shear stress and turbidity were chosen. The analyses of the numerical results enabled us to demonstrate that resuspension events can be modeled as a Poisson process: Interarrival time, intensity of peak excesses and duration being exponentially distributed random variable.

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ELUCIDATING THE VALUE OF ECOSYSTEM SERVICES IN THE GULF OF MEXICO FOR THE PURPOSES OF CONSERVATION AND RESILIENCE: PART 2-THE VALUE OF SERVICES

We present the results of a primary valuation study of ecosystem services provided by three important Gulf of Mexico habitats (marsh, mangrove, and oyster reefs) that takes into account climate change stressors such as sea level rise and freshwater inflow. The results are useful in quantifying the link between resilience of socio-ecological systems. Many ecosystem services are non-market goods and cannot be valued using market data. Challenges and needs for primary research exist in the area of passive use values, i.e. not associated with any direct use of ecosystems, especially in the Gulf of Mexico region. Estimating passive use values requires a stated preference approach where survey respondents are asked a series of questions in order to elicit their willingness-to-pay to ensure that the ecosystem services continue to be delivered. Surveys were developed and delivered via an internet surveying firms' randomized panel of 1200 households in the region. Each respondent was requested to choose among alternative policy scenarios attributes, one of which was cost (monetary) to the individual. The attribute levels of the ecosystem and associated services were varied across different scenarios and choice questions as well as across respondents so that rich information was elicited for a broad range of different program alternatives.

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CREATURES OF THE SUBTIDAL DEEP: EXAMINING LONG-TERM IMPACTS OF THE DEEPWATER HORIZON OIL SPILL ON INFAUNAL COMMUNITIES IN TERREBONNE BAY

The Deepwater Horizon oil spill severely impacted productive coastal zones, with the state of Louisiana, already experiencing anthropogenically-driven rapid subsidence rates and hypoxic coasts, receiving the brunt of the onshore oiling. Limited knowledge exists on how this additional stressor will affect coastal communities in the long-term. To greater understand sub-lethal affects of residual PAHs stemming from oil exposure, infaunal communities in Terrebonne Bay were investigated due to their importance as food sources for commercially important species and as critical links between detritus and higher-level consumers. Sediment cores were used to collect infaunal species, which were analyzed for abundance, diversity and vertical distribution. Additional sediment and environmental properties were collected to provide the environmental context for the infauna in addition to expected "oiled" and "unoiled" conditions. Abundance, composition, and diversity differences were not statistically explained by oil exposure, but rather independently by site. No evidence was found for shifts in vertical distributions of infauna between oiled and unoiled sites. Prior research has determined that various infaunal species act as bioremediators after contamination, directly by the metabolizing of harmful contaminants, and indirectly through bioturbative activity that facilitates microbial degradation of toxins. Future research will focus on furthering knowledge of infaunal processes leading to community resiliency after disturbances, and the rate of these processes in oil exposed gradients.

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THE IMPORTANCE OF MESOPREDATORS ON JUVENILE OYSTER PREDATION: A FIELD TEST

The eastern oyster, Crassostrea virginica, is a target species for many restoration efforts along the East and Gulf coasts of the United States. These restoration efforts typically seek to enhance populations by combating recruitment limitation. While recruitment of oysters is considered to be limited by low larval supply, or substrate availability, post-settlement

mortality, particularly attributed to predation, can also lead to recruitment failure of benthic invertebrates such as oysters. Our previous research suggests that only the exclusion of predators by caging was effective at increasing oyster recruitment, regardless of seeding or settlement cues. Many species are implicated in predatory mortality of post-settlement invertebrates, although decapod crustaceans are among the most important. It has been suggested that the dominant predators of small oysters could be mesopredators such as mud crabs, despite their lower per capita consumption rates than larger predators, due primarily to their high abundances on oyster reefs. However, most studies have employed lab consumption rates and field densities to draw these conclusions. In our study, we deployed a series of different sized mesh cages at a field site in southeast North Carolina to exclude groups of predators in order to test whether mesopredators are responsible for the majority of juvenile oyster predation. In addition, we tested whether location within a site – reefs fringing marshes or reefs on mud flats – also had an effect on the importance of mesopredators on juvenile oysters.

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THE PHYTOPLANKTON COMPOSITION ACROSS THE WORLD'S COASTAL ECOSYSTEMS

Ten regional data sets of phytoplankton counts have been collected for the work of the SCOR WG137 aiming at comparatively analyzing global patterns of phytoplankton dynamics in coastal ecosystems. The regional data sets, which mostly covered Northern Europe and North America, totals about 40,000 samples of either volume or carbon biomass, and have been combined with hydrochemistry data. The coastal ecosystems ranged from brackish water with salinity <5 in the Baltic Sea to salinity >30 in Dutch coastal waters. Mean annual temperatures ranged from about 6 °C in the boreal coastal ecosystems in the northern Baltic Sea to about 20 °C in the subtropical Patos Lagoon in Brazil and Neuse River Estuary in North Carolina. Mean nutrient concentrations also ranged over several orders of magnitude. The mean phytoplankton composition of an ecosystem, partitioned into 5 functional groups (diatoms, dinoflagellates, cyanobacteria, cryptophytes and chlorophytes), was estimated for each of the 83 coastal ecosystems in the database. These sites clustered in three groups: 1) shallow nutrient-rich systems with strong tidal mixing and potential Si-limitation, 2) deeper sites with variable mixing pattern, higher temperatures and potentially shifting nutrient limitation, and 3) deeper sites with variable mixing pattern and nitrogen limitation. The proportions of the different functional groups were then correlated with mean characteristics of the hydrochemistry data. Diatoms dominated most coastal ecosystems and were literally always present in the samples, whereas the proportion of dinoflagellates decreased with increasing nutrient concentrations. The abundance of cyanobacteria and chlorophytes was strongly coupled to salinity, and mostly found in the Baltic Sea. The study confirms that across the broad range of coastal ecosystems nutrients, mixing patterns and salinity are the main structuring factors for the phytoplankton community.

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IMPACT OF OCEAN ACIDIFICATION ON METABOLISM AND ENERGETICS DURING EARLY LIFE STAGES OF THE INTERTIDAL CRAB *PETROLISTHES CINCTIPES*

It is likely that responses to ocean acidification (OA) relate to an organisms' habitat and their capacity to buffer environmental change. Few studies assess physiological impacts on coastal intertidal organisms living in environments with CO_2-induced pH decline greater than Intergovernmental Panel on Climate Change (IPCC) projections for year 2100. We use the intertidal crab *Petrolisthes cinctipes* to explore how energetic processes are altered at different stages during exposure to low pH. Physiological mechanisms allowing larvae to transition from stable pH environments (pelagic) to habitats with pH fluctuations (intertidal) are poorly understood. Metabolic rates, total protein, dry weights, total lipids and C/N were determined in late stage embryos, zoea I larvae and juvenile crabs reared in ambient pH (7.96±0.04) or low pH (7.60±0.06). Embryos exposed to pH 7.60 (7 to 10 d) displayed 11% and 6% mean reduction in metabolism and dry weight, respectively, however responses varied by brood indicating significant maternal effects among the offspring of six females. Larval and juvenile metabolism was not affected by pH. Larvae contained 7% less nitrogen and C/N was 6% higher in individuals reared at pH 7.60, representing a switch from lipid to protein metabolism. Dry weight was 19% reduced in juveniles after 8 d in pH 7.60, however differences disappeared at 33 d suggesting compensation after longer-term exposure. Differences in energy partitioning likely underlie varying sensitivities to OA among stages and clutches. In addition, the observed variation among broods in response to pH suggests a potential for this species to adapt to low pH. It is probable ocean acidification may select for more CO_2-tolerant conspecifics and change the population structure of *P. cinctipes* in near future oceans.

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SEDIMENT SETTLING VELOCITY FROM ADVS AND SETTLING TUBES: AGREEMENT OVER A RANGE OF PARTICLE TYPES AND HYDRODYNAMIC CONDITIONS

Acoustic Doppler Velocimeters (ADVs) can be used to measure (i) relatively large (~cm/s) sediment settling velocities (w_s) by direct Doppler measurement of sediment motion and (ii) relatively small w_s (~mm/s) by assuming a Rouse balance between upward Reynolds flux and downward settling. Advantages of ADV-based w_s estimates include the fact that they do not impact local turbulence, they are resilient to high energy and biofouling and, for the two methods examined here, they are relatively insensitivity to precise calibration of acoustic backscatter for sediment concentration. In the past, however, these ADV-based estimates of w_s had not been confirmed by independent measurements of w_s using other instruments observing the same particle populations. Here, independent observations of w_s utilizing gravimetric and video settling tubes are shown to be consistent with these two types of ADV-based w_s measurements for large and for small w_s, respectively. Direct Doppler-based ADV estimates of w_s were collected for sand in a laboratory mixing tank and confirmed by a Rapid Sediment Analyzer gravimetric settling column. Rouse-balance ADV estimates were collected in the York River estuary for muddy flocs and confirmed in-situ by a particle tracking/particle image velocimetry settling column. These lab and field-based observations both suggest that, in the absence of significant particle aggregation/disaggregation, (i) measurement of w_s and (ii) w_s itself are both relatively insensitive to the local intensity of fluid turbulence for w_s up to several cm/s.

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SEASONAL PATTERNS OF DENITRIFICATION AND NUTRIENT FLUXES IN COASTAL MARSHES OF A PROGRADING DELTA, WAX LAKE, LOUISIANA

Wax Lake Delta (WLD) is an area of prograding deltaic wetlands, that is building as a result of water and sediment diverted from the Mississippi River (MR) via the Atchafalaya River and the Wax Lake outlet. This area provides an ideal ecosystem to study the effects of a large-scale river diversion on the biogeochemistry of coastal wetlands. We quantified the relative importance of denitrification and benthic nutrient fluxes in different wetland habitats receiving diverted MR water. Sediment-water column nutrient, oxygen, and N2 fluxes were measured in intact sediment cores collected at two stations (Creek Mouth - CM and Island Edge - IE) in Mike Island, WLD. Fluxes were estimated during October and December 2010, and April and July 2011. Sediment nitrate uptake was higher at IE relative to CM, and ranged from -75 μmol m-2 h-1 (Dec 2010) to -274 μmol m-2 h-1 (Oct 2010). Ammonium release from the sediment was highly variable with the lowest fluxes in July 2011 and the highest in October 2010. Overall, fluxes ranged from -5.8 to 492 μmol m-2 h-1 for both stations. Phosphate was taken up by the sediment with higher fluxes at IE (range: -1.3 to -20.8 μmol m-2 h-1) relative to CM (range: -0.4 to -10.4 μmol m-2 h-1). The average net fluxes of N2 were positive (82 μmol m-2 h-1), indicating that denitrification is occurring. Net N2 fluxes were higher at IE (123 μmol m-2 h-1) compared to CM (82 μmol m-2 h-1). The highest N2 fluxes were measured in April 2011 and the lowest in July 2011. The higher denitrification rates during spring are associated with both higher nitrate uptake and higher nitrate concentrations (118 μM) in MR water. The strong efflux of ammonium also indicates that other N transformations such as dissimilatory nitrate reduction to ammonium (DNRA) are likely occurring. These results suggest a strong coupling between seasonality and the biogeochemistry of sediments, influencing the fate of nitrate introduced via MR water in coastal marshes of WLD.

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IMPACTS OF BLUE MUSSELS ON EELGRASS: EVALUATING THE POTENTIAL FOR LIGHT TO MODERATE INTERSPECIFIC INTERACTIONS

The sign and strength of habitat modification by ecosystem engineers may vary based on environmental conditions, but this idea has seldom been investigated. Estuaries represent ideal systems to explore this hypothesis due to their strong, dynamic abiotic gradients

and the ubiquity of benthic ecosystem engineers. The blue mussel (Mytilus edulis) is an ecosystem engineer that modifies the structure and biogeochemistry of the seafloor and overlying waters, and, in doing so, influences other species in the community. Previous studies suggest that the effects of mussels and other bivalves on seagrasses can vary from inhibitive to facilitative depending on environmental conditions, but this idea has yet to be tested. We assessed the potential for light to moderate the effects of blue mussels on eelgrass (Zostera marina). In eelgrass mesocosms, we factorially manipulated mussel abundance (presence/absence) and light intensity (high/low). We estimated weekly changes gross primary production by measuring oxygen fluxes in mesocosm incubations. After four weeks, we determined changes to sediment and porewater biogeochemistry, as well as eelgrass growth, morphology, and phytochemistry. We found that mussels increased concentrations of porewater sulfides and sediment acid-volatile sulfides (FeS). Mussels also increased community respiration, shifting the system to net heterotrophy. Despite these biogeochemical changes, mussels had little impact on eelgrass condition. Eelgrass thrived under high-light, while shaded plants grew more slowly and eventually deteriorated, with no lateral shoot production. We conclude that eelgrass is generally resilient to mussels and their effects on benthic biogeochemistry, even under stressful, low-light conditions. Our study is unique in testing the effects of habitat modification across an environmental gradient. Furthermore, our findings represent an important contribution to the understanding of bivalve-seagrass interactions.

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POLE-WARD EXPANSION OF MANGROVES ALONG THE EAST COAST OF FLORIDA CORRESPONDS TO A DECREASE IN THE FREQUENCY OF EXTREME COLD EVENTS

We used a 27-year record of Landsat satellite imagery to determine whether the extent of mangrove vegetation is increasing, decreasing, or unchanging along the east coast of Florida. Our results indicate that (1) there has been a significant expansion in the distribution of mangroves at the northern end of the range in Florida; (2) the expansion is associated with a long-term reduction in the frequency of "extreme" cold events (# of days < -4°C), but not with other meteorological variables; and (3) the response of mangrove vegetation to the frequency of "extreme" cold events is a threshold response. This analysis presents evidence from direct observations that mangroves are moving pole-ward on regional scales, and further suggests that the expansion is associated with recent warming trends.

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EXAMINING FUNCTIONAL CHANGE FROM MANGROVE EXPANSION INTO MARSHLANDS IN THE NORTHERN GULF OF MEXICO

Recent evidence suggests that mangroves are extending their range northward in the Gulf of Mexico (GoM), which may generate important functional changes for coastal ecosystems. To better understand these changes, we have been conducting research in GoM barrier islands where marshlands are being increasingly colonized by the black mangrove Avicennia germinans. We follow a space-for-time substitution approach, where we compare islands with different stages of colonization, complemented with field and lab experiments. We address a number of metrics indicative of ecosystem function, including plant diversity and abundance, shoreline topography, nekton habitat use, herbivory, decomposition, and carbon accumulation. Here we report on the first two years of research. At low colonization sites where only small and scarce mangrove trees occur, marsh plants surrounding the trees perform well. In contrast, extensive exclusion of marsh plants occurs in highly colonized sites. Thus, mangrove encroachment on marsh communities entails profound changes in plant diversity and zonation. In general, consumption by herbivores is more intense on leaves of the common and foundational marsh species Spartina alterniflora than on A. germinans, although large spatial variability occurs for both plant types. In addition, the identities of leaf-grazing herbivores appear to differ between the two plant types. Senesced S. alterniflora leaves decompose more quickly than senesced A. germinans leaves, although the differences are small and spatially variable. In concert, these results suggest that important changes in plant carbon flow to primary consumers, and cascading impacts on secondary and higher-level productivity, may occur as mangroves replace marshes. We also discuss shifts expected in carbon accumulation, as well as shoreline topography and protection from wave scouring. This research may assist strategies of adaptive management as mangroves expand into coastal marshes.

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THE LONG TERM IMPACTS OF INCREASING DISSOLVED CO_2 CONCENTRATION ON LEAF OPTICAL PROPERTIES IN EELGRASS *ZOSTERA MARINA* L

Increasing atmospheric CO_2 concentration is predicted to have a positive impact on seagrass productivity due to the increase in available substrate concentration for carbon fixation. The positive influence of ocean acidification on photosynthesis and survival of the temperate eelgrass *Zostera marina* L. has been demonstrated, but the long-term impacts on photoacclimation remain unquantified. This study compared the differences in optical properties of eelgrass leaves grown in controlled aquarium tanks at different pH levels by bubbling compressed CO_2 gas to provide pH environments ranging from 6.0 up to 8.0 for 5 months during the summer of 2013. Pigment concentrations and light absorption efficiency (absorptances, absorption coefficients and optical cross-sections) were measured monthly. After 2 months of acclimation to increased CO_2 concentrations the pigment contents showed significant differences among the pH treatments. Plants growing at low pH had lower total chlorophyll concentrations per fresh weight and per area. However there was no significant difference in chlorophyll-a specific absorption coefficient among pH treatments, suggesting no difference in terms of package effect. The total carotenoid concentrations per fresh weight showed significant decrease with decreasing pH but no difference per leaf area. The decreases in both types of pigment contents per fresh weight at low pH environments may result from the increased thickness of leaves which is consistent with increased fresh weight per area with decreasing pH. On the other hand the down-regulation of only chlorophyll content per area while carotenoid concentrations remained constant among differing pH conditions might be an indication of photoprotective role of accessory pigments. Since CO_2 will be excessively available for photosynthesis at low pH environments carbon fixed per light harvesting complex will be maximized which may downregulate the chlorophyll pool size of reaction centers.

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MONITORING, MODELING, AND MANAGING IN THE SHALLOW-WATER REGIONS OF CHESAPEAKE BAY

Shallow-water regions (depth < 2 to 3 m) of deep, expansive estuaries are emerging as "hot spots" for water quality management. Water quality impairments include harmful algal blooms, poor water clarity, and intermittent hypoxia. The shallow-water regions of Chesapeake Bay are subject to all of these impairments and others. We review first, the distinctive shallow-water monitoring program in place in the bay. The program combines discrete sampling and continuous monitoring at fixed stations and from mobile vessels. Examples of water-quality impairments detected by this system are provided. In 2010, a Total Maximum Daily Load for nutrients was developed for the bay to remove these and other impairments. The TMDL is subject to re-evaluation in2017. As part of this re-evaluation, the management model of the system is being upgraded with a focus on shallow water. Performance of the existing model and progress on the upgraded model are presented.

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COASTAL HYPOXIA AND OCEAN ACIDIFICATION AS COUPLED ECOSYSTEM STRESSORS: A VIEW FROM THE LEFT COAST

Changes in the oxygen inventory of the ocean and their sensitivity to climate variability are issues of increasing scientific and policy focus. Across coastal systems, upwelling-dominated shelf systems such as those of the California Current Large Marine Ecosystems (CCLME) have been predicted to be particularly vulnerable to climate-mediated shifts in the size and intensity of both hypoxic and ocean acidification (OA) zones. Such shifts can have important implications for spatial and ecosystem-based management planning. At the same time, growing ocean observing networks in the CCLME are now offering unprecedented insights into the formation of hypoxic zones over dynamic shelf systems. Using the Oregon shelf as a model system, we will synthesize our current understanding of how hypoxia events vary in time and space and evaluate the potential vulnerability of upwelling systems to climate-mediated changes in ocean circulation and oxygen content. We will also use new datasets from co-deployed in-situ pH and pCO2 sensors to assess the conditions that drive

the strongest expression of hypoxia and OA as coupled stressors from the mid-continental shelf to the surf-zone.

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SEDIMENT DYNAMICS AND THE DELAWARE ESTUARINE TURBIDITY MAXIMUM

This project aims to characterize and describe the along and cross-channel sediment dynamics in the middle reach of the Delaware estuary. Data was collected over the course of two years, including 4 cross-channel tidal surveys, several mooring arrays, and 8 along channel surveys spanning over 200 km up-channel from the mouth. Suspended sediment concentrations (SSC) from water samples were correlated with optical backscatter (OBS) point measurements and Acoustic Doppler Current Profiler (ADCP) backscatter signals. These correlations were used to describe the spatial and temporal distribution of sediment in the estuary. Sediment fluxes were then estimated using SSC and velocity data from the cross-channel tidal surveys and mooring arrays. Despite seasonal variability of the along-channel sediment distribution, the time variability of the cross-channel distribution seems to be driven mostly by the lateral dynamics. This analysis will determine whether the cross-channel sediment suspension and transport affect the along-channel sediment distribution. This has significant implications, as previous studies have shown sediment resuspension to affect the along-channel distribution of primary productivity by limiting the light availability.

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MOORED OBSERVATIONS OF TIDAL AND SPRING NEAP VARIATION IN STRATIFICATION AND EXCHANGE FLOW ACROSS SIX ESTUARIES

Over the past decade we have deployed arrays of Doppler Current meters and CT sensors in a number of estuarine systems. This includes the Hudson River Estuary, Newark Bay, The Passaic River, Raritan River, Delaware Bay and the James River. All of these deployments lasted 6-weeks or more and thus contained several spring neap cycles. In general all of these systems exhibited marked spring/neap variability in stratification while some show a strong spring neap variation in estuarine exchange flow. In contrast there was significant scatter in the tidal period variability in stratification across these systems with some (such as the Delaware Bay) showing enhance stratification on the flood tide while other (such as the Passaic River) exhibiting enhanced stratification during the ebb tide. These data sets will be analyzed to relate the spring/neap variability in both estuarine exchange flow. vertical stratification and tidal period variability in salinity to the Horizontal Richardson Number (Simpson Number) and aspects of channel morphology.

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ENVIRONMENTAL TOLERANCES AND DRIVERS OF DEEPWATER SEAGRASS CHANGE - IMPLICATIONS AND TOOLS FOR COASTAL DEVELOPMENT MANAGEMENT

While research has focused on shallow water coastal seagrasses over the last 20 years, little is known of the ecological role, tolerances and drivers of their deepwater (>10) counterparts. Within the Great Barrier Reef World Heritage Area, deepwater seagrasses are estimated to occupy more than 35,000 km2 of the reef lagoon. These deepwater meadows are often within the footprint of port and shipping activity where dredging, associated plumes and ship movements are major threats to their long term survival. We present initial findings from an ongoing research program to determine the drivers of seasonal and inter-annual change in deepwater tropical seagrasses. Seagrass abundance, seed bank status and recruitment, productivity, irradiance and temperature along with detailed spectral profiles have been measured in three geographically distinct deepwater seagrass meadows since early 2012. Manipulative lab experiments were initiated in mid-2013 to assess the adaptive photophysiological characteristics of the plants. This research will identify key environmental cues which will be used in developing local management strategies for mitigating coastal developmental impacts along the Great Barrier Reef.

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A COMMENT ON ENHANCING HORSESHOE CRAB (*TACHYPLEUS TRIDENTATUS*) POPULATION SIZE BY LARVAE REARING AND JUVENILE RELEASE IN TAIWAN

Horseshoe crabs (Tachypleus tridentatus) is nearly local extinction in Taiwan. To enhance T. tridentatus population size, larvae rearing and releasing has been processed through years in Taiwan. The growth rates of larvae under laboratory rearing were various and most larvae died during it's molting, despite the water quality controlled strictly. The diet prepared for 2nd instar larvae was mostly composed of Artemia spp larvae due to convenience. Such unitary food resource might cause nutrient deficincy on early instar larvae. So, we suggest to provide diverse food including macro-algae and seagrass for well nutrition. Since 1990s, tens of thousands of early instar larvae per year were released to coastal areas. Due to difficulty to mark or tag on horseshoe crab larvae, new scientific survey methods should be established to examine this releasing effects. Based on the high moratlity rate in early instar larvae, we suggest to release 3rd or older instar larvae instead of early instar larvae. Since it's weak locomotion ability and the necessity for hinding from predator, horseshoe crab larvae should be released in late afternoon on an intertidal wet flat beach during low tide. For long term conservation purpose, the optimal releasing location would be a unpolluted bay,where three types of habitats occur nearby: (1) spawning area, littoral zone with coarse sand, which facilitates oxygen penetrating for embryo development, (2) juvenile nursing ground, intertidal zone with fine sand and silt, providing organic matter as food and coverage for hinding,and (3) adult living area, where ca. 20 – 30 meter depth at the continental shelf. After a long run, the releasing site may be assigned as a protected area, for maintaining a stable horseshoe crab population.

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VARIATIONS OF PHYTOPLANKTON COMMUNITY IN SHENZHEN BAY, CHINA

Seasonal and interannual phytoplankton succession in Futian Mangrove Reserve of Shenzhen Bay was analyzed during the period 2008–2012. Total number of phytoplankton was composed of 158 taxa, belonging to 6 phyla, 7 classes and 53 genera. Among those, class Bacillariophyceae were 114 species (72.1%), Class Chlorophyceae were 23 species (14.5%), Class Dinophyceae were 8 species (5.1%), cyanophyceae were 6 species (3.8%), Euglenophyceae were 5 species (3.2%) and Cryptophyceae were 2 species (1.3%). Phytoplankton succession, with fall-winter diatom blooms and summer cyanobacterial blooms, was probably driver by changes in nutrients, water temperature and turbulence. Phytoplankton abundance in the investigated period showed the highest value as 5.2×10^7 cells/L in 2009 and the lowest value as 1.4×10^5 cells/L in 2008. Phytoplankton abundance in 2009 was highest in summer, fall and winter during this study, fluctuating between 9.4 ×10^6 and 5.2×10^7 cells/L, while that in 2012 was highest in spring with 2.7 ×10^6 cells/L. It has shown a considerable decrease in spring phytoplankton abundance during 2008-2011, compared to that from the period 2001-2002. While summer phytoplankton abundance varied from 1.1 ×10^6 and 9.4×10^6 cells/L during 2008-2012, compared to that varied from 3.0 ×10^6 and 3.7×10^6 cells/L during 2001-2002. Keywords: Phytoplankton, diatom, Shenzhen Bay, succession Funded by the Natural Science Foundation of China under contract No: 41276100 and the Natural Science Foundation of Fujian Province of China under contract No: 2011J01279 Email: chencp@xmu.edu.cn

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BIOGEOCHEMICAL PROCESSES OF THE FORMATION OF HYPOXIA WATER OFF THE CHANGJIANG ESTUARY

Hypoxia zone at the Changjiang estuary is one of the largest coastal hypoxia zones in the world, but the understanding of distribution and formation mechanism of the hypoxia water is very preliminary. We have carried out five comprehensive summer cruises since 2006

with special focus on hypoxia water off the Changjiang Estuary. An overview discuss on the causes of hypoxia or oxygen depletion waters was descripted and discussed based on inorganic carbon system (DIC, Alk, pH), nutrients, chl a, in situ control experiments and some biogeochemical parameters such as DOC, POC, opal. The high chlorophyll a, high DO concentration, profoundly decreased DIC concentration and elevated pH were observed in the surface water. Meanwhile, the correspondingly increased DIC and depletion of dissolved oxygen were observed in the bottom water, together with the regeneration of nutrients. A three-end–member mixing model was used to calculate the biological uptake of dissolved inorganic carbon (DIC) and nutrients removal in upper 5m plume areas and also the bottom regeneration of DIC and nutrients in near bottom water. The semi-quantitative analysis proves that the locally produced primary productivity deposits to the bottom contributed to the organic carbon decomposition in the bottom with the contribute value about 80%. Furthermore, the perfectly coupled silicate uptake by diatom bloom in surface plum area was related with the regeneration of silicate in the bottom oxygen depletion area, which implied that the decomposition of POC setting from the local surface diatom-dominated bloom could greatly contribute to the bottom hypoxia off Changjiang Estuary.

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SIMILAR SOIL CARBON INCREASES IN TWO YOUNG AFFORESTED MANGROVE PLANTATIONS DESPITE SUBSTANTIALLY DIFFERENT GROWTH RATES

Mangroves have been threatened by deforestation and other anthropogenic disturbances over the past century, and mangrove afforestation has been undertaken in many countries to compensate for these historical losses. Since the realization of mangrove forests' high carbon (C) sink potential, C sequestration has been incorporated among restoration goals. In China, a fast-growing but non-native mangrove species, Sonneratia apetala, has been popularly used for mangrove afforestation due to its fast growth and high biomass. We conducted a comparative study on the C sequestration rates and belowground biomass of afforested mangroves consisting of S. apetala and of a native species, Kandelia obovata, using repeated measures from forests aged 0-6 years at a forestation site in southeast China. Our results indicate that surface sediment C content increased with age; however, there was no significant difference between C accumulation rates in the two mangrove species, despite significantly higher biomass increase in S. apetala. At both sites, soil C density (0.61%-0.73%) was low compared to estimated global averages, yet accumulation rates (111 to 188 g C m-2 y-1) were in line with current global averages. In summary, the fast-growing S. apetala did not sharply increase soil C stocks in young forests as expected, despite much higher belowground biomass accumulation relative to K. obovata forests of the same age. For increasing soil C stocks in mangrove plantations, forest age appears to be a much more important driver than tree species.

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ECOLOGICAL IMPLICATIONS OF NUTRIENTS DYNAMICS IN THE JIULONG RIVER-ESTUARY SYSTEM, CHINA

Eutrophication and harmful algal blooms (HAB) have become the major water quality concerns in China. An integrated analysis was carried out to explore the nutrient dynamics of the Jiulong River-Estuary. This analysis suggested that watershed nutrient loads during the past 30 years were the main cause of nutrient (N, P) enrichment and eutrophication in the estuary. DIN export from the watershed increased 2-3 fold during the period 1985-2007. A declining N:P ratio was observed in both river and estuarine waters since the 1990s, due to higer P loadings as a consequence of waste discharge from proliferating livestock husbandry and application of excessive phosphate fertilizers to cash crops. Dissolved silica (DSi) in the river was fairly high (averaged 250 μM) and relatively stable in estuarine water during the past few decades due to a balance between decreased vegetation and increased damming. The aquatic ecosystem was switching from strongly to weakly P limited. A dual nutrient (N and P) management strategy is necessary to mitigate eutrophication in the Jiulong River Estuary, with a focus on animal wastes in the north Jiulong tributary and over fertilization in the west Jiulong tributary. In addition, storm-driven sharp increases of nutrient loads and changes in nutrient stoichiometry (more ammonium and particulate P) might have been connected with algal blooms in the adjacent estuary and Xiamen Bay. Further research should address the impact of accelerating land-use change on the nutrient cycle of this subtropical aquatic ecosystem.

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ANT DIVERSITY AND COMMUNITY STRUCTURE ON COASTAL DUNES

1. Coastal dunes are complex and fragile ecosystems. The zonation patterns of these habitats support high biodiversity. Although coastal dunes have been examined in primary succession studies for more than one hundred years, invertebrates have received much less attention than other creatures. 2. In this research, we studied ant diversity and community structure on dunes, and examined the relationship between ant community composition and environmental factors. In addition, we used ants as indicators to reveal the influence of anthropogenic disturbance on these habitats. Quadrat sampling and hand collecting were used to sample ants on coastal dunes fringing of the northern Gulf of Mexico. 3. 46 species were found totally, and diversity increased from foredunes to backdunes. Ant community structure was different between habitats, and between intact and disturbed dunes. The number of functional groups, however, was similar in each habitat. As we expected, ant community composition was influenced by vegetation structure such as plant cover, floral diversity, and the presence of leaf litter. 4. Our study emphasizes the importance of protecting the whole dune system, especially the backdunes which support high diversity but are often completely destroyed. Data from this research provides a benchmark to examine trajectories of coastal dune ecosystem degradation or recovery.

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VARIATIONS OF ARCHAEAL COMMUNITIES IN SEDIMENTS OF COASTAL DELAWARE

Microbes are essential players in global nutrient cycles. As the third domain of life, members of Archaea are important components in the microbial communities. In recent years, Archaea have received much attention due to their ubiquity, diversity and abundance spanning terrestrial and marine habitats, yet we know little about their distribution patterns and adaptation mechanisms. In this study, we combined culture-independent analyses with geochemical measurements to investigate the archaeal communities from five sediments in Delaware coastal areas, including the Great Marsh, Inland Bays and three sites in the Broadkill River. Delaware sediments housed 158 archaeal operational taxonomic units (OTUs), including ubiquitous mesophilic groups and close relatives of deep biosphere species. The distributions of these archaeal groups were different among sites. However, community structure remained generally constant throughout all depths within each site, regardless of the environmental gradients down-core. This suggests site selection of the microbial communities, and high level of vertical relatedness within the sediments.

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ADDITIVE AND OPPOSING EFFECTS OF MULTIPLE ENVIRONMENTAL STRESSORS ACROSS REALISTIC TIME SCALES

Global change and its effects on the world's biota have become the focus of a large body of research. There is increasing recognition that multiple environmental stressors may operate in conjunction to produce synergistic or antagonistic interactions. However, our understanding of how multiple stressors affect organismal biology remains unclear. In particular, few studies have evaluated multiple stressor effects over time scales relevant to the focal organism. Here, we manipulated stressors across life stages of the Olympia oyster (Ostrea lurida), a species of restoration concern along the U.S. west coast. We parameterized treatments using field data from central California estuaries and exposed oysters to simultaneous stressors (warming x hypoxia) and a latent stressor (low salinity). Contrary to expectations, we found additive and opposing effects of warming and hypoxia on oysters. Warming above typical field temperatures increased growth by 28%, whereas hypoxia decreased growth by up to 61%. Surprisingly, we found no synergistic interaction between warming and hypoxia. Oysters were able to partially recover from warming and

hypoxia after 12 weeks of benign conditions but treatment groups were still statistically distinguishable. Finally, we found that low salinity exposure resulted in high oyster mortality, but this was not related to stressor exposure during early life history. In other words, we found no latent effects of warming or hypoxia upon low salinity tolerance. Based on field data, the relevant stressors to oyster ecology are likely to be estuary dependent. Low salinity is likely a primary stressor in San Francisco Bay versus hypoxia which is likely a dominant stressor in Elkhorn Slough. This work suggests that: 1) multiple stressors may not always produce synergistic or antagonistic interactions, 2) stressors may produce opposing effects and 3) the relative importance of environmental stressors in estuaries depends upon the regional context.

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EVALUATING THE SPAWNING ACTIVITY OF THE AMERICAN HORSESHOE CRAB (*LIMULUS POLYPHEMUS*) IN GREAT BAY ESTUARY, NEW HAMPSHIRE, USA

The Great Bay Estuary, NH is near the northern end of the geographic range of the American horseshoe crab. Great Bay is a unique area because there are few ideal beaches for spawning, horseshoe crabs have not been harvested in NH in recent years, and there is no organized monitoring program to keep track of changes in the population. The goals of this project were: 1) initiate a monitoring program in Great Bay, 2) identify the most dominant spawning locations, and 3) compare the temporal patterns of spawning activity with more thoroughly studied locations. To begin to evaluate the horseshoe crab population of Great Bay Estuary, a pilot-monitoring program was developed in 2012. Over 2,000 adult horseshoe crabs were counted in three prominent areas of the estuary. Surges in the numbers of horseshoe crabs sighted corresponded to the most dramatic increases in water temperature during the spring. Interestingly, more horseshoe crabs were observed earlier in the season in areas at the head of the estuary, where the water warms up the fastest. In addition, there were significantly more horseshoe crabs sighted during the day (an average of 24.7 ± 7.8 horseshoe crabs) than at night (an average of 5.8 ± 2.4 horseshoe crabs; paired t-test, $p<0.05$, $n=29$), which is a pattern not typically reported in other spawning areas. In addition, peaks of horseshoe crab mating activity occurred during the time of the new moon, but not during the full moon cycles, which contrasts with other regions. However, additional data from 2013 will be necessary before firm conclusions can be drawn about the spatial and temporal patterns of horseshoe crab spawning in the Great Bay Estuary.

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BRACKISH MARSH SPECIES WITH DIFFERENT PATTERNS OF PLANT REGROWTH IN THE DARK: IMPLICATIONS FOR RECOVERY FOLLOWING DISTURBANCE

Coastal wetlands are prone to disturbance from fire, herbivory, and coastal storms, which can remove or bury aboveground plant biomass. Wetland plant species may employ different strategies to replace biomass after disturbance, and some species may recover more quickly than others. To examine differences in regrowth capacity of two common brackish marsh species, *Schoenoplectus americanus* and *Spartina patens*, we measured regrowth of aboveground biomass in the dark using intact sods of vegetation and soil that had been exposed to different CO_2 treatments (395 or 720 ppm) for 2 years. At the conclusion of that study, aboveground biomass was removed by clipping, and mesocosms were moved to a dark room where biomass was clipped at regular intervals to quantify temporal patterns of regrowth. The two species exhibited dramatically different patterns of regrowth in the dark. Regrowth capacity of *S. patens* (C_4 grass) was exhausted within 3 months of being placed in the dark, regardless of prior CO_2 exposure, while *S. americanus* (C_3 sedge) continued to regrow for two years in the dark, with differences in temporal patterns of regrowth based on prior CO_2 exposure. After dark treatment, a subset of the mesocosms was moved to a greenhouse to further examine differences in regrowth capacity. No regrowth of *S. patens* occurred in the light after two years of dark exposure, whereas *S. americanus* fully recovered and flowered, although there was no effect of prior CO_2 exposure on final biomass. These results suggest that *S. americanus* may have an advantage over *S. patens* at surviving and recovering from disturbances, such as burial by sediment in which light is blocked for extended periods. To our knowledge, this is the longest record of dark survival by a wetland plant species.

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ASSESSMENT OF COLLECTION METHODOLOGIES OF THE MANGROVE SALTMARSH SNAKE, *NERODIA CLARKII COMPRESSICAUDA*

Effective techniques of collecting organisms are vital to estimating populations, determining conservation status and acquiring material for genetic studies. Snakes are generally considered the most difficult reptile to study because of their cryptic behavior and habitat use. In particular, a snake that is both aquatic and arboreal poses additional challenges, such as the case with the mangrove saltmarsh snake, *Nerodia clarkii compressicauda.* This species occupies mangrove communities in coastal southern Florida and northern Cuba. It shows a variety of morphological characteristics and is thought to readily hybridize. They feed exclusively on fish, typically bask on the prop roots of the red mangrove, *Rhizophora mangle*, and are efficient swimmers. Their mixed habitat use and foraging behaviors make them often difficult to collect. The purpose of this study is to test the effectiveness of using modified minnow traps to capture individuals of the mangrove saltmarsh snake in estuarine communities in southern Florida, including Everglades National Park and the Florida Keys. Comparisons between alternative collection techniques will be made. Ecological and morphological distinctions among populations will be discussed.

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GLOBAL ALERT: MANAGING RIVER-TO-OCEAN CONNECTIONS FOR TRASH

This paper will present the strategy, design and implementation of a project funded by the World Bank's Global Partnership on Oceans to track and mitigate trash flowing into oceans from inland waterways and rivers. The Global Alert project recognizes marine debris as a global problem requiring local and regional solutions. Global Alert is a web based, collaborative platform that will provide a mechanism to link the world's rivers to the ocean, providing a visual tool to identify and mitigate trash hotspots which are floating or situated along coastlines. Engaging multilateral, private and NGOs as global partners, the Global Alert platform will help identify areas where plastic pollution impacts critical natural resources, ecosystems, rivers, coasts, and communities. Rivers and streams eventually are some of the main delivery mechanisms for plastic entering the sea. Global Alert will help narrow the gap in awareness between those living "upriver," and those "downstream" at the ocean. With this mechanism, Global Alert platform allows for localized management and pollution prevention, while connecting municipalities, NGO organizations and companies, who all play a role in cessation and removal of plastic debris from our waterways, on a local, regional, or global scale. Global Alert features maps and a rating system for measurement of plastic waste that can be viewed on Google Maps, showing both hotspots and best management practice. The high-impact potential of Global Alert rests in two unique innovations for managing this environmental problem: 1) integrated information collection, sharing, and analysis, and 2) the creation of a visual snapshot of the situation. Knowledge from the map will also support the deployment of regular and sustained prevention programs, recycling, and furthering water stewardship programs.

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CONSIDERING TIDAL MARSHES IN IPCC NATIONAL GREENHOUSE GAS INVENTORIES – RESEARCH NEEDS

The IPCC publishes guidelines that provide methodologies for estimating national inventories of anthropogenic emissions by sources and removals through sinks of greenhouse gases. Countries currently use these guidelines to estimate the greenhouse gas inventories they report to the United Nations Framework Convention on Climate Change. The latest-set of guidelines, published in 1996, included a volume on emissions and sinks associated with land use change and management of Forest Land, Cropland, Grassland, Settlements, and Wetlands. Due to the progress in wetlands research and the increasing recognition of the importance of wetlands in the global carbon cycle the IPCC decided to update their guidance on wetlands, dedicating an entire volume to wetlands, which will be available by the end of 2013. The volume considers constructed, freshwater, and coastal wetlands; the latter includes all tidal wetlands. Through this exercise we have identified a number of uncertainties regarding how modifications of tidal wetlands affect carbon sinks and emissions. In this presentation I will review the research available and focus on research needs we have identified.

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GEOCHEMICAL MONITORING OF GAS COMPOSITON AND FLUXES WITH OXYGEN DEMAND AT CCS SITE IN SOUTHWESTERN EAST SEA OF KOREA

This study was conducted to develop monitoring techniques for the methane and carbon dioxide seepage, and to understand their geochemical interaction with sediments and the overlying water the present state before injection of CO2 into underground storage at the continental shelf area of Korea According to the onboard observation of the variation of dissolved oxygen (DO) in the incubation chamber, the oxygen consumption rate was larger in sandy mud (8.6 ± 0.3 mmol O2 m-2 d-1) than in the muddy sand (5.3 ± 0.2 mmol O2 m-2 d-1). The methane diffusive flux from sediments to the overlying water was low (0.5 to 10 μmol CH4 m-2 d-1). Isotopic composition (δ13C) is from -45.9 ± 0.7 to -76.9 ‰ VPDB. Based on the isotopic composition (δ13C) and CH4/(C2H6+C3H8) ratios, the methane was determined as biogenic methane in origin, although not exclusively. Carbon dioxide flux in the sediment-water interface ranged between 32.4 and 92.2 mmol CO2 m-2 d-1. The δ13C values of CO2 in the sediments were -1.18 to -1.65 ‰ VPDB. The gasses (CH4 and CO2) concentration and 13C were showed no significant change in core sediments. The correlation between methane or carbon dioxide release and oxygen demand at the water-sediment interface shows very close relationship and can allow an assessment of a realistic benthic metabolic quotient. This approach will be concerned with geophysical data and will be utilized to accumulate the background information before CO2 injection.

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DOWNSTREAM INCREASE OF ARSENIC MOBILITY IN THE ARROYO SEDIMENTS OF A DESERTIC ARID SEDIMENTARY BASIN AFFECTED BY REMNANTS OF GOLD MINING NEAR SAN ANTONIO, SOUTHERN BAJA CALIFORNIA

The evaluation of potentially toxic element (PTE) geochemical mobility in ephemerous stream sediments allows assessing their bioavailability and related environmental risk in arid coastal environments. This approach was applied to arroyo sediments of the San Juan de los Planes drainage basin (south-eastern Baja California peninsula), heavily polluted by tailing and smelting solid wastes of ancient gold mining. In this desertic arid climate, fluvial PTEs migrate downstream to La Ventana Bay (Gulf of California) only during episodic rains, typically induced by tropical cyclones. To assess the concentrations of total and mobile PTEs, the fine-grained (<63 μm) arroyo sediment sub-samples were treated by the following leaching solutions: a) concentrated HNO3; b) 1M HCl and c) reducing ascorbic citrate solution. The As and Cd concentrations in leachates were determined by electrothermal AAS, whereas Cu, Fe, Mn, Pb and Zn by flame AAS. Total As concentrations remained high and fairly constant (230-270 mg kg^{-1}) along the entire sampled section, while its mobile reactive phase roughly increased downstream starting with low values of 2.3 mg kg^{-1} (0.99 % relative contribution) at the highest point of the arroyo near the Au smelter ruins and reaching 191-220 mg kg^{-1} (75-89 % relative abundance) in the mouth sediments near la Ventana Bay. Other PTEs displayed a different pattern. High total concentration peaks occurred in the middle of the arroyo, while the mobile phase remained low and proportional to their total concentration, revealing low reactivity of these PTEs. The high mobility of As represents a potential ecological risk for the San Juan de Los Planes drainage basin, especially due to the constant use of the polluted soils for agricultural purposes. Moreover, easily dissolvable mobile As could reach the underlying aquifer after rains, representing a direct hazard to the population and might be transported further through the subterranean estuary thus reaching the bay.

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THE DEGREE OF URBANIZATION ACROSS THE GLOBE IS NOT REFLECTED IN THE δ15N OF SEAGRASS LEAVES

Identifying and managing sources of nutrient pollution is among the most challenging aspects of seagrass conservation. As such, there has been significant interest in developing reliable indicators of nutrient pollution in seagrass beds. Many studies have documented the relationship between δ15N ratios of seagrass leaves and nearby sources of nutrient pollution. However, only a few studies have examined this relationship on regional or global scales. To address this gap in knowledge, we performed a large-scale meta-analysis of seagrass δ15N ratios. We compiled a dataset of δ15N ratios in seagrass leaves from 79 independent locations and compared these values to the size of the human population and the amount of fertilizer used within a radius of 10, 50, 100 and 200 km around the sample locations. Our results indicate that seagrass δ15N ratios are not correlated with fertilizer use or the size of the human population on either spatial scale. However, seagrass δ15N ratios are positively correlated with the absolute value of the latitude. In addition, genera that can be classified as temperate, such as Amphibolis, Posidonia and Zostera, have higher mean δ15N ratios than tropical genera, such as Thalassia, Halophila and Syringodium. The latitudinal gradient in seagrass δ15N ratios suggests an underlying pattern in discrimination or a different isotopic baseline on a global scale. The actual mechanisms responsible for the correlation between seagrass δ15N ratios and latitude remain unknown.

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HYDRODYNAMIC MODELING OF THE ST. JOHNS RIVER IN SUPPORT OF A WATER SUPPLY IMPACT STUDY

The St. Johns River Water Management District recently completed a multiyear study quantifying the effects of water withdrawals from the St. Johns River. The St. Johns River Water Supply Impact Study (WSIS) examined the effects of water withdrawals on the hydrodynamics of the river including variations in water level, discharge, velocity, salinity, and water age. The effects of water withdrawals need to be assessed over nearly 300 river kilometers and a wide variety of time scales: short-term storms, seasonal droughts, and long-term sea level rise. Long-term effects also include changes to the watersheds such as urbanization and the completion of large water resources projects. A three-dimensional hydrodynamic model is needed to address these questions and provide results to environmental scientists for further analysis. The three-dimensional hydrodynamic model selected for this study is the Environmental Fluid Dynamics Code (EFDC) (EPA 2011). The model domain stretches from the shelf just outside of the river mouth, near Jacksonville, FL, through Lake Harney, approximately 300 km upstream. The model is tested and confirmed for a ten year period (1996-2005) in order to include a large range of meteorological conditions. Included are an extensive drought (late 1999 through 2001), an extremely wet winter (1997-1998), and an active tropical season (2004). The model is shown to successfully hindcast water level, discharge, salinity, and water age throughout the domain and over different time scales. A combined water withdrawal of 6.79 m^3s^{-1} upstream of DeLand leads to small changes in salinity within the estuarine portion of the river. The average relative difference values show an increase in the mean salinity of 0.01 to 0.3 PSS78 in the estuarine portion of the river between Acosta and Shands Bridges. The withdrawal also leads to very small salinity differences (<0.05 PSS78) in the middle St. Johns River.

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WHY COMPARE HEMISPHERES: A CASE OF SALT MARSH RESPONSE TO SEA-LEVEL CHANGE

Climate, hydrogeomorphology and biota interact to determine the ability of coastal marshes to maintain themselves under changing sea levels. While models broadly predict the interactions, their applicability is limited to a range of conditions less than the range of marshes and environmental drivers. We evaluated differences between eastern North and South American marshes in controlling factors of marsh response to sea level change. Eastern South American climate demonstrates a strong bifurcation compared to the latitudinal gradients in eastern North America. Dry, cold conditions in Patagonia are not represented in North America. Significant differences also exist in Holocene history and past and present sea-level change patterns. Marsh plant and animal communities show hemispheric species differences, especially in the high marsh and in colder climates. We consider that South American marshes have the potential to expand and qualitatively alter our understanding of marsh response to sea-level change. Unfortunately, they lack much of the quantitative information available for North American marshes to populate current models.

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HEAVY METALS IN *TACHYPLEUS GIGAS* EGGS

Development of coastal areas not only has made some grounds unsuitable for horseshoe crab nest but also brings along pollution. Hence the urgency to study the natural condition of sediment of these spawning grounds to gauge the effect of contaminants, particularly heavy metals on the development of horseshoe crab eggs. In this study, heavy metals concentrations were evaluated for Tachypleus gigas eggs and sediments from two different sites, Sitiawan (Perak) and Banting (Selangor) in Peninsular Malaysia. Nine elements

detected in eggs and sediments were Arsenic (As), Cadmium (Cd), Copper (Cu), Ferum (Fe), Magnesium (Mg), Nickel (Ni), Lead (Pb), Selenium (Se), and Zinc (Zn). There were significant differences ($P<0.05$) in As, Cd and Cu concentrations before and after 28 days incubation for horseshoe crab eggs from Banting. Only As and Cd differed significantly for eggs from Sitiawan. These results showed the increased of As, Cd and Cu in horseshoe crabs eggs after incubation. However, eggs samples used for each respectively sites were of pooled eggs. Therefore, it is possible that some of the eggs clumps were of different maternal sources, therefore may have caused the high variations in the metals concentrations. Sediments samples analysis showed that sediments from Sitiawan are highly contaminated with As, Cd, Cu, Fe, Mg, Ni and Pb when compared to Banting. However, Zn was higher Banting, while Se only detected in Banting sediments. Key words: Tachypleus gigas, eggs, sediments, heavy metals

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THE POTENTIAL FOR LAUREL WILT DISEASE-INDUCED HOST SWITCHING IN THE PALAMEDES SWALLOWTAIL (*PAPILIO PALAMEDES*)

Large-scale ecological perturbations (e.g. biological invasions) may facilitate the mixing of evolutionarily unfamiliar species and increase opportunities for "ecological fitting" whereby species that possess compatible traits form novel associations, despite having no shared co-evolutionary history. In the southeastern US, laurel wilt disease (LWD) has spread throughout many Coastal Plain habitats. Most incidences of LWD-induced mortality occur in redbay (Persea borbonia), an abundant sub-canopy species and well known as the primary larval host of the palamedes swallowtail butterfly (Papilio palamedes). Following the decline of redbay, it is unclear to what extent this abundant herbivore may achieve fitness on other Lauraceous hosts. We hypothesize that the exotic camphor tree (Cinnamomum camphora) will be an especially suitable host due to high LWD-resistance and its similarities to redbay. We collected adult female palamedes and larval food plants (redbay and camphor) from local populations at the Grand Bay National Estuarine Research Reserve in coastal Mississippi. Larvae were reared individually in the laboratory. Differences in survivorship between larvae reared on redbay versus those reared on camphor were not significant until the beginning of the fourth instar; thereafter only one larva died on camphor. In total, 87% and 46% of larvae survived on redbay and camphor, respectively. Although the duration of each larval stage was significantly greater on camphor, only larvae in their second and third instar showed significantly lower growth rates on this species. Indices of metabolic efficiency for fourth instar larvae suggested no clear pattern that favored one host species over the other. These results indicate that camphor may be a suitable host for palamedes larvae in the aftermath of LWD and subsequent decline of redbay. Current work focuses on oviposition preferences of adult females and the value of palamedes as a pollinator to local plant populations.

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LOUISIANA'S COASTAL INNOVATION PARTNERSHIP PROGRAM: INCORPORATING INNOVATIONS INTO PROJECT IMPLEMENTATION

The Coastal Protection & Restoration Authority of Louisiana (CPRA) is charged with implementation of Louisiana's 2012 Coastal Master Plan over the next few decades. To achieve Master Plan goals in the most cost-effective, timely and sustainable way, CPRA has partnered with The Water Institute of the Gulf to develop the Coastal Innovation Partnership Program (CIPP). The CIPP solicits and evaluates innovations that could be used by CPRA or other coastal entities to achieve the most efficient, cost effective and sustainable approaches to project implementation, monitoring and adaptive management. The CIPP aims to gather, evaluate and endorse the best ideas across the state, country and world in order to incorporate them into projects in the 2012 Coastal Master Plan or facilitate their development or use in future plans. By formalizing an open innovation process, the CIPP helps foster a culture of innovation by encouraging and stimulating out-of the box thinking and then providing a formal evaluation mechanism. The CIPP evaluates innovations on their ability to foster successful project delivery by ensuring quality, time, and cost improvements. The program is anticipated to continue to evolve and expand in future years. The CIPP will initially focus on innovations that have been demonstrated in a relevant environment. The long-term focus of the CIPP will incorporate innovations which may require more study that address issues that the Coastal Master Plan identified as significant, but for which a solution does not yet exist. Long-term program goals include providing opportunities for individuals or organizations to seek funding to further develop more conceptual innovations and foster an innovative culture around restoration and protection activities. Through both the near-term and long-term goals, the CIPP will establish an innovation portfolio that is applicable to implementation of all aspects of the 2012 Coastal Master Plan.

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INFLUENCE OF SURFACE-SEDIMENT ΩARAGONITE ON RECRUITMENT, DISPERSAL, AND SIZE OF JUVENILE SOFT-SHELL CLAMS (MYA ARENARIA)

Anthropogenic impacts on estuarine pH resulting from eutrophication, freshwater input, and acid deposition (nitrogen and sulfur) have been occurring for decades and can have negative implications for carbonate saturation (Ω) and carbonate bearing fauna residing within these habitats. Surficial sediments are typically more acidic than overlying waters, exposing recently-settled benthic invertebrates to undersaturated conditions. Although we are beginning to understand the biological implications of shifting pH within the water column, few studies have assessed the effects of surficial-sediment acidity on benthic invertebrates. We investigated whether surface-sediment aragonite saturation (Ωaragonite) affects burrowing and dispersal rates of juvenile soft-shell clams (Mya arenaria). Two size classes of juvenile clams (0.5–1.5 mm and 1.6–2.5 mm) were subjected to a range of surface-sediment Ωaragonite conditions (0.21–1.87; pH 6.8–7.8) comparable to those measured in the Bay of Fundy, Canada. Results revealed that Ωaragonite significantly affected burrowing behaviour, with more clams accepting high Ωaragonite sediments. Clams were subsequently exposed to one of two different flow conditions in a laboratory flume. Both flow and Ωaragonite significantly affected the number of clams remaining in sediment cores, regardless of clam size class and flow speed, with more clams remaining in high Ωaragonite sediments. Additionally, a field study was conducted to assess whether abundance and size of M. arenaria recruits was related to surface-sediment Ωaragonite, the results of which will also be presented. This study examined the role that surface-sediment Ωaragonite plays in soft-shell clam recruitment. When assessing the effects of carbonate saturation state on juvenile infaunal bivalves, future studies should consider surface-sediment Ω to adequately understand how these organisms may be affected by anthropogenic impacts on coastal and estuarine pH in the future.

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BEYOND SPAT: FAUNAL COLONIZATION OF OYSTER REEF RESTORATION MATERIALS

Populations of the eastern oyster (Crassostrea virginica) in the Chesapeake Bay have been declining since the late 19th century as a result of over fishing, habitat destruction, poor water quality and diseases. In Maryland, recent actions to reverse this decline include the establishment of oyster sanctuaries and the construction of 3-dimensional oyster reefs. However, supplies of oyster shell are limited, making artificial substrates, such as concrete rubble, economically attractive for reef construction. Spat settlement and oyster densities and biomass have been the primary measures used to assess the success of oyster reef restoration; although restoring ecosystem services such as improving water quality and providing habitat for diverse faunal communities are often the primary goals of reef restoration. In the St. Mary's River, Maryland, a subestuary of the Chesapeake Bay, a project is underway to construct a series of 3-dimensional mound reefs using a variety of different construction materials. While the cores of the reefs are being constructed of concrete, a veneer of either oyster shell or concrete rubble is being placed over some of the reefs. In order to evaluate the recruitment of faunal communities to the substrates used in the reefs we performed a study in which trays containing either concrete rubble or oyster shell were deployed adjacent to the restoration site and at a nearby site with an existing shell bar oyster reef. After seven weeks of colonization, the trays at the reef site had significantly higher organismal abundances than the trays at the empty bottom site. However, there was no difference in diversity between the substrate types. This suggests that concrete rubble is a viable option for oyster reef construction, although oyster shell appears to be the ideal candidate for reef building.

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COMPARISONS OF SPATIAL AND TEMPORAL CHANGES IN PHYTOPLANKTON COMMUNITY COMPOSITION USING VISUAL AND DNA BARCODING IDENTIFICATION TECHNIQUES IN THE ALTAMAHA RIVER, GA, USA

Water quality alterations often trigger rapid changes in species abundance and community composition of primary producers. Developing efficient methods to assess these changes are essential to improve our ability to measure food web support to higher trophic levels and conserve and manage aquatic resources. The objective of this study was to examine the response of phytoplankton community composition to spatial and short-term temporal environmental changes in the Altamaha River, GA, USA using both visual and DNA barcoding techniques. Visual identification methods are labor-intensive, and distinguishing among species can be difficult due to limited morphological variation and high environmental plasticity. Use of DNA barcoding techniques has the potential to alleviate some of these difficulties and contribute increased speed and resolution to

the characterization of microalgal assemblages. We performed two intensive sampling regimes, one during a dry period, and one following a rain event at five permanent sampling stations along a transect in the Altamaha River-Estuary transition zone. Daily water quality measurements and samples for phytoplankton species composition analysis were taken. Differences in phytoplankton community composition among sites as well as changes in composition between sampling events were assessed using both microscopy and PCR-based environmental DNA libraries using a photosystem II gene (psbA). Site differences in species composition were not detected using either method, and temporal changes were observed using both methods ($p<0.05$, ANOSIM). However, visual methods yielded higher diversity of eukaryotic taxa, whereas molecular techniques were biased toward abundant, smaller species and revealed a higher diversity of cyanobacteria. Given that each technique provides different information, some combination of the two would be most useful to assess phytoplankton community composition as a component of water quality monitoring programs.

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ARTIFICIAL TEMPERATURE MANIPULATION TO SIMULATE CLIMATE CHANGE IN A MANGROVE AND SALT MARSH SYSTEM

The distributional ranges of mangrove species are primarily limited by freezing events in higher latitudes where colder temperatures limit growth and survival. In recent years, a northern range expansion of mangrove species has been observed, likely due to the diminishing occurrences of fatal freezing events associated with climate change. Co-occurrence of mangroves with salt marsh has been increasing as a result of the northward range shift. Little is known about how salt marsh species will affect mangrove sensitivity to freezing events which may in turn alter expansion success by influencing survival rates in newly established areas. If salt marsh species alter mangrove species survival at higher latitudes, determining changes in interactions with salt marsh species under increasing temperatures is important for predicting relative species dominance under climate change conditions. We performed two experiments in Florida within a latitudinal transition gradient between mangrove and salt marsh species dominance to address these questions. First, we performed an artificial freezing experiment to determine if the presence of two species of salt marsh (*Salicornia virginica* and *Distichilis spicata*) altered the survival of three mangrove species *(Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa*) under temperatures of -5°C. Rates of 3-month old mangrove seedling mortality was reduced for all three species in the presence of *D. spicata*, but showed no differences for 6-month old mangrove seedling survival in the presence of *S. viriginica*. Second, we performed an artificial warming experiment to determine if increased average air temperature will alter mangrove growth and subsequent interactions with salt marsh species. With on-going warming temperatures, we predict that all species growth rates will increase, with a more rapid shift in communities from salt marsh to mangrove dominance compared to ambient conditions.

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A MODEL OF SCIENCE-DRIVEN, COMMUNITY-BASED EFFORTS TO MITIGATE WATERSHED EROSION AND LAND-BASED SEDIMENTATION TO CORAL REEFS IN CORAL BAY, US VIRGIN ISLANDS

Coral Bay (CB), on the eastern side of St. John, US Virgin Islands, is a rural community on steep slopes surrounding sensitive coastal habitats including mangroves and reefs. The increasing rate of land development, poor land use planning, sporadic regulation of development projects, and limited funding for effective mitigation strategies continue to pose major environmental problems for CB. Developed land is accessed mostly by a network of unpaved roads, which have become both primary sources of sediment and primary drainage conveyances of sediment-laden runoff into the bay. Based on previous scientific studies and observations during rain storms, the Coral Bay Community Council (CBCC), a non-profit community planning group, identified sediment erosion as a priority issue threatening the marine ecosystem and the community's quality of life. From 2009-12 the CBCC partnered with the Virgin Islands Resource Conservation & Development Council (V.I. RC&D), NOAA, EPA, local homeowners, the VI government, and scientists from three universities to conduct stormwater management work targeting sediment control with funding from NOAA's Coastal and Marine Habitat Restoration Project Grants through ARRA. For this effort the CBCC and project partners implemented best management practices (BMPs), which ranged from paving roads to constructing sediment detention basins. These projects were completed in late 2011 and the net effects of these actions on marine sedimentation and water quality continue to be evaluated through ongoing monitoring. To date this project has resulted in: reduced sediment erosion, restored upland habitat and increased public awareness about stormwater management, BMPs, and sedimentation. This collaborative effort between scientists and local and federal management entities provides a model of science-driven, community-based efforts to mitigate erosion problems that can be emulated across the wider Caribbean.

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ESTIMATING POLICY-RELEVANT VALUES FOR ECOSYSTEM SERVICES PROVIDED BY SEAGRASS BEDS IN SWEDEN

Seagrass beds provide valued inputs to society's economic welfare. Estimates of these values raise awareness of society's dependence on seagrass and support improved decision-making. We focus on the eelgrass beds on Sweden's west coast, where substantial losses have occurred in the last 20 years. Our valuation model links underlying ecosystem functions to the delivery of ecosystem services and, ultimately, the provision of seagrass 'goods' valued by society: commercial fish harvest, nutrient uptake, carbon sequestration, and an improved recreational experience. We apply economic methods to value the contribution of these goods to economic well-being based on benefits transfer. While we acknowledge many concepts of value, we rely on anthropocentric-based economic values, which assume a trade-off exists between protecting seagrass beds or protecting other environmental resources (or, alternatively, producing valued market goods). Our interdisciplinary contribution emphasizes the economic value of improved recreational experiences due to improved water clarity provided by seagrass beds, which filtrate particles, stabilize sediment and reduce re-suspension. Our model considers local effects, where economic values may differ across beds that may otherwise seem to have similar ecological characteristics. Despite some limitations in non-market economic valuation methods (e.g., estimating the value of ecosystem services that give rise to multiple goods) the results nonetheless shed light on the values at stake for policy makers given the scarcity of resources available for environmental protection. The results highlight the inescapable trade-offs between development and conservation, motivate the enforcement of environmental compensation regulations aimed at offsetting seagrass injuries (from e.g., development projects or spills), and help to inform an equitable and efficient scale of compensatory payments.

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SUCCESSFULLY SEQUENCING SWIMMING CRAB MITOCHONDRIAL DNA: DIVERSITY OF BLUE CRABS AND SPECKLED CRABS OF THE SOUTHEASTERN ATLANTIC COAST

The blue crab (Callinectes sapidus) is both economically and ecologically important in estuarine communities and is commonly found along with other ecologically important species, including the lesser blue crab (Callinectes similis) and the speckled crab (Arenaeus cribrarius). The purpose of this investigation is to determine the genetic diversity of the lesser blue crab and the speckled crab by sequencing the 16s rRNA mitochondrial loci. To collect crabs we seined at Hunting Island State Park, SC, Tybee Island, GA and Cockspur Island, GA. Crab limbs were extracted in the field, stored in ethanol, and then DNA was extracted following standard molecular methods. We were able to successfully sequence lesser blue crab and speckled crab 16S rRNA gene by using the published C. sapidus mitochondrial genome. Currently, our data show a greater diversity among the speckled crabs; this is expected due to little economical demand for the species along our immediate coast. Also, we have caught more crabs on Hunting Island. These results were expected due to anthropogenic influence on Tybee Island in the form of tourism, fishing pressure and container ship traffic. Thus far, our data suggest panmictic populations in blue and speckled crab species. A small amount of genetic diversity has been found in the blue crab which could indicate an unhealthy ecosystem, and could suggest alleles are becoming fixed due to removal (i.e., overfishing).

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MARINE PARK ZONING TO REDUCE IMPACTS ON SEAGRASS MEADOWS IN THE GREAT BARRIER REEF WORLD HERITAGE AREA, QUEENSLAND, AUSTRALIA

Australia's Great Barrier Reef World Heritage Area is one of the world's largest marine parks and includes 344,400km^2 of coastal lagoon and coral reefs. A key feature of the World Heritage Area and marine park, is the presence of one of the last remaining large populations of the dugong (*Dugong dugon*) and the seagrass meadows on which they feed. In recent years there have been concerns about the health of the reef particularly in the southern half with declining coral cover, a reduction in seagrass abundance and elevated numbers of dugong deaths reported. The marine park was rezoned in 2004, increasing the

area with a high level of protection (no take zones) from less than 5% to 33%. One rationale for this change was to increase the resilience of key species and habitats, such as dugongs and seagrass, by addressing environmental risk and setting a minimium level of protection. We used mapped and modeled seagrass distributions to quantify the reduction in impacts that the rezoning achieved. Impacts such as trawl fishing can now only occur in 34% of the park (59,244km^2) down from 54% (177,732km^2) before the rezoning. Of the area available for trawling in 2009 only 15% is actually trawled down from 23% prior to the rezoning. In the southern part of the park 13 regions totaling nearly 4000km^2 were included in Dugong Protected Areas located over known seagrass meadows and dugong populations. These measures were again primarily directed at reducing fishing impacts but have also influenced coastal management decisions and the rezoning. We discuss how our analysis provides a tool to inform management on ways to reduce stress on seagrass meadows and we outline some of the gaps in this approach.

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A NEW GREEN MACROALGAE BLOOMING IN A TROPICAL ESTUARY: ARE MACROALGAE THE MINE-CANARIES OF BISCAYNE BAY NUTRIENT STATUS?

Green macroalgal blooms are becoming a common problem in coastal waters and estuaries. This study describes the first occurrence of a persistent macroalgal bloom of the genus Anadyomene J.V. Lamouroux (Cladophorales, Anadyomenaceae) in the world and particularly in Biscayne Bay, Florida, USA. The morphological-based identification of species was verified by a molecular analysis that sequenced the variable C1D2 region of the large subunit (LSU) nrDNA. Results indicate that the bloom is composed of two species: Anadyomene stellata, reported previously for Florida, and a diminutive perforate undetermined species, Anadyomene sp., potentially representing an introduction in the area. General surveys in Biscayne Bay based on a stratified random design, to visually estimate the percent cover of submerged aquatic vegetation, date from 1999; using the same methods recent intensive surveys of the detected bloom were conducted once a year from 2010 to 2012. Results show that the Anadyomene bloom densities have persisted since 2005 through 2012 covering an area of approximately 60 km2 of seagrass habitats. The spatial distribution of the bloom is restricted to the central inshore section of the Bay, an area affected by canals and groundwater discharges. The persistent 75 % cover reported for several sites, has caused significant negative impacts to seagrass beds. This bloom occurring adjacent to metropolitan Miami, might be the first sign of nutrient accumulation in Biscayne Bay, and adds to the world trend of increasing green macroalgal blooms occurring at enriched coastal waters.

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THE ROLE OF RESEARCH PROGRAMS IN BRINGING ENVIRONMENTAL AWARENESS, PARTICIPATION AND ENGAGEMENT TO A MULTILEVEL STUDENT GROUP: A TRANSFORMATIONAL EXPERIENCE FROM THE LAB, TO THE FIELD, TO THE CLASSROOM

The Marine Macroalgae Research Laboratory at Florida international University has a high interaction of High School Students through LTER Schoolyard, and under and graduate students. The consciousness of the rapid globalization of our society, plus the imminent environmental coastal problems, together with the educational revolution going on at college level, has challenged my practice as a lecturer (classroom activities) and as researcher (mentor) of students of all levels. To create programs that will integrate the research into the promotion of transformational experiences from the field/lab into the classroom requires deep understanding of how to bring into practice the scientific method, through all levels, from research to active learning activities in classrooms. The ability to form global citizens requires the promotion of awareness and participation that will result in engagement of students in scientific sound reasoning actions, either in research, or managerial or simple educated decision making. Here I describe several practices that have work, and several that have failed within a high school, undergraduate and graduate students' mixture; and propose a set of organized steps to follow in order to bring research into an active learning classroom within a global perspective and active learning environment.

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LIGHT THRESHOLDS DERIVED FROM SEGARASS LOSS: AN UPDATE FROM THE GREAT BARRIER REEF, AUSTRALIA

Tropical seagrass meadows are diverse and can be highly dynamic, but the drivers and their thresholds are not well documented. Measures of light and seagrass abundance during event-driven loss of seagrass were used to identify light thresholds in multi-specific meadows dominated by Halodule uninervis in the northern Great Barrier Reef, Australia. Seagrass cover was measured at ~3 month intervals from 2008 to 2011 at three sites: Magnetic Island (MI) Dunk Island (DI) and Green Island (GI). Photosynthetically active radiation was continuously measured within the seagrass canopy, and three light metrics were derived. Complete seagrass loss occurred at MI and DI, but not GI. Mean daily irradiance (Id), percent of days below 3 mol m-2 d-1, and the number of hours of light saturated irradiance (Hsat; calculated using literature-derived data on saturating irradiance) correlated with short-term changes in seagrass abundance. These relationships enabled us to identify threshold levels of light that were associated with anomalously high levels of seagrass loss (>50% seagrass loss in any 3 month period). Light levels that were well below the thresholds resulted in more severe loss of seagrass than those just below the threshold and this has highlighted that any improvement in light levels can be beneficial for seagrasses. We are continuing to measure seagrass abundance and light levels at more than 20 sites in the GBR, with some datasets now exceeding 5 years in duration. These findings enable comprehensive analysis of light as a driver of change in tropical seagrass communities and we will present an update of findings from this long-term dataset.

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DIATOM AND DINOFLAGELLATE BLOOMS IN THAU LAGOON (SOUTHERN FRANCE) OVER THE LAST 20 YEARS : DICHOTOMY IN CONTROLLING FACTORS

Time series of phytoplankton between 1990 and 2011 in Thau lagoon indicate a bimodal temporal distribution for diatoms (maxima in March and June) and dinoflagellates (maxima in March and September). The diatom March peak was inversely related to salinity, with a one month time lag, indicating an influence of freshwater and nutrient inputs. The dinoflagellate peaks in March and September had no relationship to salinity but were related positively to sea surface temperature. Detailed examples on a monthly time scale show the influence of conventional nutrients such as nitrate and phosphate on diatom blooms. In contrast, blooms of dinoflagellates such as Alexandrium catenella/tamarense can occur following periods of 3 weeks without rain. High frequency sampling of such a bloom showed a significant inverse relationship between cell densities and dissolved organic nitrogen concentrations that was not apparent for diatom blooms. In contrast to those, A. catenella/tamarense blooms on a monthly time scale are partly due to organic nutrient supplies, a feature that allows in situ net growth rates of about 1.3 d-1, a value higher than that generally attributed to this particular species complex.

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QUANTIFYING THE EFFECTS OF A BEACH NOURISHMENT PROJECT ON HORSESHOE CRAB (*LIMULUS POLYPHEMUS*) SPAWNING ACTIVITY, EGG DEPOSITION, AND JUVENILE HABITAT ON PLUMB BEACH, BROOKLYN, NEW YORK

The Atlantic horseshoe crab (Limulus polyphemus) is an ecologically and economically important species, and the only extant member of its kind in the United States. Valued as bait for the fishing industry and its bacteria-detecting blood by the biomedical industry, perhaps its greatest value is as a critical food supply for migratory shorebirds when females come ashore each spring to lay thousands of eggs on sandy beaches of the Atlantic coast. In collaboration with NYC Audubon, an ongoing study of spawning, egg density and juvenile distribution has been carried out at Plumb Beach, Jamaica Bay; New York's most important breeding beach. In 2013 the study was expanded to include the impact of a beach re-nourishment project carried out by the Army Corps of Engineers in late 2012. While the addition of 127,000 cubic yards of sand to the highly degraded western portion of this 1.8 km beach was primarily done to prevent further erosion of the Belt Parkway, the project created an opportunity to examine the response of horseshoe crabs to the beach modification. Data from summer 2012 revealed that few spawning horseshoe crabs used the degraded western beach zone, which was comprised primarily of sand bags, rocks and

anaerobic mud. While it was initially hypothesized that the crabs would respond positively to the new expanse of sandy beach, preliminary data from the 2013 spawning season reveals that despite the replenishment, most crabs still prefer the relatively undisturbed eastern area. Data will be collected throughout the summer and findings will be presented. Data will entail night surveys of spawning crabs at full and new moons, core samples to quantify egg densities on each beach, and timed visual surveys of the mudflats to census foraging juveniles. Support is provided by NY Sea Grant, grant 0537101091- a CSTEP Program of the NYSED, and grant 2R25GM06003-05 of the Bridges to the Baccalaureate Program of NIGMS.

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LOUISIANA'S COASTAL REPORT CARD: CONCEPT AND APPROACH

Team members from The Water Institute of the Gulf and the Coastal Protection and Restoration Authority worked collaboratively to develop an approach for producing a report card for coastal Louisiana. The need for a report card stems from the extensive natural and human-induced changes occurring along the coast that may impact the resiliency and sustainably of the natural environment and local communities. As such, the report card would serve to inform citizens, resource managers, policy makers, and public officials on the state of the environmental, social, and economic condition of coastal Louisiana. Reporting on the conditions of the natural and built systems in an integrated context reinforces the connection between the resiliency of coastal communities and the sustainability of the coastal environment. Although regional- and project-specific report cards have been developed, there has not been a comprehensive report card produced for coastal Louisiana that pulls together data on both the ecosystem and local communities. A report card prototype was developed using a preliminary set of performance measures related to the natural environment (land, water, wildlife and fisheries) and the built system (flood risk, economy, and culture). The prototype was shared with five focus groups across Louisiana's coast that captured diverse perspectives. The discussions with the focus groups confirmed that the report card would be a useful tool to inform coastal residents and public officials on the condition of the ecosystem and socio-economic environment. The focus groups also revealed that residents were interested in learning about action they can take in their own communities to ensure their livelihoods are sustained. The challenge ahead lies in balancing the need for localized information, while reporting on a coastwide scale and ensuring report cards encourage readers to take appropriate actions for change.

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SUBSTRATE SELECTION PREFERENCES BY PLANULAE OF THE PACIFIC SEA NETTLE, *CHRYSAORA FUSCESCENS*

The proliferation of artificial structures in the coastal zone is one mechanism that has been proposed for increased frequency of jellyfish blooms in some regions. The addition of hard substrates provides unoccupied habitat and by selecting a particular substrate on which to settle and metamorphose, the planula phase of the life history helps to determine the distribution of adult medusae. The validity of this mechanism is therefore based on the ability of the dispersive planula phase to colonize novel artificial substrates. *Chrysaora fuscescens* is the most abundant scyphozoan in the Northern California Current, but there are no published reports of the benthic scyphistoma stage of *C. fuscescens* from the field. The aim of the present work was to investigate the substrates that induce metamorphosis in *C. fuscescens* planulae in the laboratory in order to better predict habitat selection in the field. Planulae were found to respond to the interaction of substrate and orientation. Artificial substrates, including steel, copper napthenate-treated wood, and breakwater rock, were identified as viable habitat for *C. fuscescens*, and inverted was the preferred orientation. These findings corroborate past studies that indicate the important role of artificial substrates in planulae settlement, particularly in locations where natural hard substrate is sparse. This research contributes to the growing body of knowledge about the impacts that coastal infrastructure may impose on marine community structure and how such infrastructure may be designed to reduce this impact.

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SAN FRANCISCO BAY AREA NUTRIENT MANAGEMENT STRATEGIES MUST ADDRESS FUTURE NEEDS

The Clean Water Act has resulted in large improvements to the nation's water quality that coupled improved water quality assessment tools with Federal funding. As we improve nutrient control strategies to meet our evolving understanding of future threats to water quality, Federal funding has declined dramatically, and our goals have become more diverse than simply removing organic loading. Municipal wastewater agencies are simultaneously balancing managing the replacement of aging infrastructure, minimizing the discharge of emerging contaminants, and evolving their mission from wastewater treatment to wastewater resource recovery. Given these contradictory drivers, managers must ensure that their agencies' emphasis on nutrient control strategies effectively matches the environmental benefits. Because of its physical drivers and historical land management practice, San Francisco Bay has largely escaped biological manifestations of its relatively high nitrogen and phosphorus loadings. As these physical and historical drivers change, the Bay's environmental management community is working with its dischargers to determine how to most effectively proceed. Municipal agencies that provide wastewater treatment need the Bay's nutrient management strategy to consider: 1. Given our uncertainty in setting numeric nutrient standards, would it be more effective to sequentially implement nutrient management strategies and adapt future steps based on initial results? 2. To what extent could permitting be based on seasonal loadings? 3. To what extent can sub-embayment loadings be developed that allow trading of nutrient loads? 4. What is the trade-off between different nutrient loading goals and other environmental goals of maximizing treatment energy production, water re-use, phosphorus and nitrogen recovery, coastal wetlands expansion, and minimizing carbon footprint?

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USEPA'S BEACH CLEANUP PARTNERSHIPS WITH THE DEPARTMENT OF DEFENSE AND THE CALIFORNIA STATE UNIVERSITY SYSTEM TO PROVIDE IDENTIFICATION OF SOURCES OF MARINE DEBRIS

USEPA Region 9's Marine Debris Program employs existing EPA program tools and resources, and works with a host of governmental and non-governmental partners, to address the problem of marine debris both on land and in the open ocean. A major part of the USEPA R9's strategy focuses on reduction of land-based sources of marine debris, and EPA has launched a pilot beach cleanup program centered around brand name source identification of marine debris. The beach cleanup project includes segreation of debris by type, with volume and weight measurements included in addition to identification of brand names. This effort transcends a traditional beach cleanup approach by engaging the military and California college students in regimented assessment of source identification, and sophisticated field survey research techniques, which include data collection and geospatial mapping. EPA plans to use the data collected during the beach cleanups to identify key industries and manufacturers who may be sources of marine debris pollution and work with them to achieve a permanent change in the way people use and dispose of trash, especially plastics which have a particularly detrimental effect on ecosystems and, potentially, human health. The partnership with EPA enables military personnel and students to be part of an important national effort to advance sustainability and stewardship of the ocean environment. It offers the opportunity for EPA and DoD to leverage existing resources to provide regimented assessment of marine debris sources, and for college students to tie together elements of science instruction, geospatial analysis, cooperation and interaction with a federal agency, and service learning that engages with the community.

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MANAGING INTERMITTENTLY OPEN TIDAL WETLANDS: CAN WE RESTORE RESILIENT SYSTEMS?

The management and restoration of small, intermittently-open tidal wetlands presents unique challenges. The paradigm in southern California over the previous two decades has been to treat intermittently-open tidal systems as "broken" tidal systems, and management actions frequently focused on creating and maintaining permanently open tidal inlets. With the growing acknowledgement of the need to restore more "resilient" ecosystems, the concept of allowing for greater dynamics in our management practices is gaining some traction. What we need now is a paradigm for a healthy intermittent system as a template for restoration and management. But how can we allow for more dynamics in highly-urbanized, heavily constrained systems while still working within the constraints of deteriorating water quality and negative public perceptions towards closed estuaries? I will suggest several critical issues that should be addressed by the scientific community to help move toward optimal stewardship of these unique and valuable systems.

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APPLYING FRESH AND MARINE WATER MODELING RESULTS TO SUPPORT DECISIONS FOR LOCAL GOVERNMENT MANAGERS: SNOW CAPS TO WHITE CAPS

Local government water resource managers are faced with the twin challenges of climate change and increasing development in coastal watersheds, and are driven by the necessity to provide critical habitat for endangered fish in the estuary and watershed, and the requirement to protect human infrastructure from flooding. Numerical models of waters resources have been developed for the Snohomish Basin in north central Puget Sound, linking the flow of freshwater from the upper watershed (Snow Caps) through the floodplain, into the marine waters of the Snohomish River estuary and into Puget Sound (White Caps). The linked models were used to generate scenarios of fresh and marine water flow and interaction, run under conditions of future climate change, and changes in land use/land cover (to simulate development in the watershed). Scenarios were informed by the model output in order to understand effects of climate change and development on seasonal flooding, transport of contaminants from land into the estuary, changes in salt wedge intrusion into salmon habitat, and changes in the exposure of mud flats in the estuary. The scenarios are based on specific questions posed by local government staff; scenario storyboards have been shared with local and state water managers through interactive workshops and online tools. Feedback from the participants helped guide the outcome of the scenarios. The effectiveness of providing model-driven simulations and forecasts to local water managers is assessed and best practices for developing communication vehicles and disseminating the results are analyzed.

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FLOWERING AND BIOMASS ALLOCATION IN THE SALT MARSH FOUNDATION SPECIES *SPARTINA ALTERNIFLORA*

Salt marshes must maintain elevation relative to sea level in order to resist drowning and conversion to open water habitat. Given the importance of belowground plant production in maintaining marsh elevation, understanding the biomass allocation of plant species is critical. Along the U.S. Atlantic coast, smooth cordgrass (*Spartina alterniflora*) plays a dominant role in salt marsh establishment and persistence. In particular, belowground biomass production by cordgrass is an important driver of marsh accretion and elevation maintenance. We sought to understand a potential link between belowground biomass allocation and flowering in cordgrass because climate change may affect flowering phenology. It is not clear what drives the timing of cordgrass flowering on multiple spatial scales or how allocation of biomass into above and belowground structures progresses during the growing season. In this study we asked (1) what spatial and temporal patterns exist in cordgrass flowering, and (2) does the timing of flowering determine the onset of belowground biomass allocation (and thus alter marsh accretion)? We conducted field surveys and a common garden experiment on flowering phenology, and quantified the timing of biomass allocation using field sampling and a non destructive re-sampling technique (Computer-aided Tomography (CaT) scans of cores). Latitudinal-scale surveys revealed that northern marshes flowered earlier than southern; this flowering order was retained in the common garden. On local scales, the timing of flowering and density of flowering stems varied between marsh sub-habitats and across marshes. Intensive temporal sampling suggested a link between flowering time and allocation to above and belowground production. We followed up on these intriguing results with non-destructive methods, tracking biomass of individual plants through time. Our results will help inform how marsh elevation will be impacted with climate-driven shifts in phenology.

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RESOURCE MANAGEMENT INFORMED THROUGH MODELING IN THE FIRTH OF THAMES, NEW ZEALAND

Regional jurisdictional boundaries in New Zealand are arranged according to catchments and extend 12 nm offshore. This presents the ideal spatial domain from which to develop resource management and monitoring frameworks that take into account land-sea connections and cumulative effects in the marine environment. New Zealand is undergoing rapid land use changes (e.g. increases in dairy farming) while also developing shellfish and finfish aquaculture in downstream coastal waters. Sustainable development at regional scales requires the use of models to assist in spatial planning, setting limits, and adaptively managing resources. Waikato Regional Council (WRC) has commenced the development of a Marine Management Model (MMM) for the eastern Waikato coastal marine area (covering the Firth of Thames, Hauraki Gulf and Coromandel east coast) that will assist in addressing a range of resource management issues such as aquaculture development, biosecurity risks, and oil spill response. Stage one of the MMM has included the construction and validation of an underlying 3D hydrodynamic model using open-source SELFE code and models for assessing effects of aquaculture. Hindcast datasets from the hydrodynamic model provide predictions of mixing and transport processes, which in turn were used to estimate gradients of dissolved and solid wastes from existing and proposed aquaculture farms. Benthic and water column results for possible finfish developments under varying tide and wind conditions highlight potential enrichment gradients at local to regional scales. A key to success for the MMM is making outputs widely accessible, which in turn maximises their usefulness in guiding decision making and developing resource management and monitoring frameworks.

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INFLUENCES OF BENTHIC MICROALGAL PHOTOSYNTHESIS AND INVASIVE BIVALVES ON BENTHIC NUTRIENT FLUXES AND DENITRIFICATION IN NORTHERN SAN FRANCISCO BAY AND THE SACRAMENTO/SAN JOAQUIN DELTA

In the Sacramento-San Joaquin Delta region, strong salinity gradients, shallow water depths and variable amounts of primary production/algal biomass have an important effect on nutrient recycling. While concern for nutrients has been low relative to other stressors such as invasive bivalves, the role of nutrients in the ecology of this ecosystem is understudied. We are examining key processes that may regulate sediment nutrient exchange, such as changes in abiotic factors including salinity and pH, and biotic factors including benthic community composition and benthic microalgal photosynthesis. Overall rates of sediment respiration were low to moderate, reflecting overall low rates of algal production. Estimated benthic microalgal productivity was variable and surprisingly high in Delta sediments and may represent an important source of labile carbon. Denitrification rates, based on the N_2:Ar ratio approach, were between 0.6 and 1.0 mmol m^{-2} d^{-1}, similar to other mesotrophic estuarine sediments. We will present experimental and observational data on the role of invasive bivalves (*Corbicula fluminea, Corbula amurensis*) on N and P exchange and examine controls of denitrification and DNRA by benthic photosynthesis, salinity and pH.

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THE EFFECT OF EPIPHYTES ON LIGHT HARVESTING AND ANTIOXIDANT RESPONSES IN THE SEAGRASS POSIDONIA OCEANICA

Posidonia oceanica (L.) Delile is a subtidal seagrass whose leaves are commonly colonized by epiphytes. Epiphytes pose physical barriers to light penetration within the leaves, with possible significant impacts on photosynthesis. Furthermore, epiphytes can indirectly be responsible for leaf chlorosis, necrosis and senescence which are known to be related with the increase of oxygen reactive species (ROS) levels, potentially leading to oxidative stress. The aim of this work was to investigate in situ (i) the effect of epiphytes on the composition and balance of light harvesting pigments in leaves of the naturally growing

seagrass P. oceanica, and (ii) evaluate differences in antioxidant responses. Epiphytized and non-epiphytized plants were analyzed to establish potential photosynthetic pigment role-shift between light harvesting and photoprotection functions. The experiments were carried out in Cabo de Gata Natural Park, southern Spain, where epiphytized and non-epiphytized plants can be found at identical depths and light exposure. The results showed that both O2 evolution rate along the day and chlorophyll a/b ratio were higher in non-epiphytized plants, indicating a negative effect of epiphytes on photosynthesis and light harvesting. Although under high irradiance (at solar noon) the xanthophyll cycle was activated in both epiphytized and non-epiphytized leaves, the de-epoxidation-ratio (AZ/VAZ) was lower in epiphytized leaves, due to light attenuation by epiphytes. The antioxidant capacity (TEAC and ORAC essays) and the activity of the antioxidant enzymes ascorbate peroxidase and dehydroascorbate were higher in epiphytized plants, showing that epiphytes can also be a potential source of oxidative stress to P. oceanica. Our results show that despite the light attenuation effect, leaf colonization by epiphytes can also be potentially stressful and reduces plant productivity.

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ABC IS NO LONGER AS EASY AS 123. ADVANCES IN SCHOOL REPORT CARDS THAT ARE APPLICABLE TO ECOLOGICAL HEALTH REPORT CARDS

In a world overflowing with information, report cards have remained central to tracking the progress of a students academic abilities. Their ability to synthesize and communicate information quickly and easily to a wide range of people have seen report cards expand outside the school domain, and into a range of other public, private and government sectors. It is not uncommon now to see report cards that assess and track e.g. health departments, retirement funds, insurance companies and more recently the ecology of natural environments. Ecological health report cards have become an important tool for integrating diverse physico-chemical and biological data types into simple scores that can be communicated to decision-makers and the general public on a routine basis. This approach was pioneered by the Integration and Application Network at the University of Maryland Center for Environmental Science. Report card popularity and influence on natural resource management decisions have to date been the only (indirect) measures of their success and effectiveness. There has been a push recently to develop more direct measures of the effectiveness of ecological health report cards. The commonality and universal acceptance of school report cards has resulted in much of the research into the effectiveness and continued development of report cards, to have come from the schooling sector. This presentation/paper outlines recent advances in school report card design, function and research and how these findings can be applied to improve the delivery, reception and effectiveness of ecological health report cards as tools for environmental management.

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EXAMINING OCEAN ACIDIFICATION IN ESTUARINE WATERS USING THE NARRAGANSETT BAY FIXED SITE MONITORING NETWORK

Twelve Narragansett Bay stations were analyzed on a summer seasonal basis June-September and three year round stations were also examined for changes in pH levels. A number of agencies worked together to establish the Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) to assess water quality in Narragansett Bay. The stations are strategically located to transect the north-south axis of Narragansett Bay and serve as sentinels of changing conditions. These stations measure near surface and near bottom temperature, salinity, oxygen, pH and depth, and near surface chlorophyll at 15-minute intervals. PH changes may be in response to increased acidity due to higher concentrations of CO_2 as well as metabolism and salinity changes due to the nutrient and salinity gradients in Narragansett Bay. Several large freshwater rivers enter upper Narragansett Bay delivering increased nutrient loads from wastewater treatment plants and storm runoff. As a result, phytoplankton bloom concentrations and salinity tend have a north to south gradient in Narragansett Bay. PH follows this gradient with pH ranges of 9.18-6.78 in the Providence River/upper bay compared to ranges of 8.35-7.48 in the lower bay. Salinity is the main driver of pH change at the furthest north station in the Providence River as well as the furthest south station in the bay, the GSO pier, which typically has no net metabolism. The upper and mid bay stations likely have both factors affecting pH. Quantifying how much pH change is attributed to each is a goal of our investigation. Over the 15-year annual record at the GSO dock, no change in pH due to enhanced acidity has been documented in the time series record.

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THE CANADIAN WATERSHED RESEARCH CONSORTIUM: DEVELOPING MONITORING FRAMEWORKS IN SUPPORT OF CUMULATIVE EFFECTS ASSESSMENT

A 2006 review of cumulative effects assessment (CEA) in Canada concluded that it was not contributing to the sustainability of valued ecosystem components and should be replaced by regional environmental assessments and effects frameworks. To encourage the development of monitoring frameworks in support of CEA at the watershed level the Canadian Water Network is supporting end-user driven research in six places across Canada. Two of these areas are estuarine: the harbour of Saint John New Brunswick and the estuaries of the Northumberland Strait region. This talk will outline the development of these projects and what they hope to deliver in April 2015 at the end of their three years of funding.

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HYPERTEMPORAL LAND AREA CHANGE ANALYSIS IN COASTAL LOUISIANA

Coastal Louisiana wetlands currently experience the highest rate of wetland loss in the contiguous United States. Recent trend analyses show that if this loss were to have occurred at a constant rate, it would equate to Louisiana having lost an area the size of one football field per hour during the 1984-2010 observation period. Documenting and understanding these rates and how they change through time is necessary for effective planning and design of protection and restoration projects. Previous analyses have been limited in their ability to dissect rates of wetland loss into finer temporal increments due to insufficient dates of imagery for analysis. The analyses of landscape change presented here used between 66 and 133 dates of classified Landsat MSS, TM, and OLI data to track wetland change rates through time. Summary data are presented for the 1973–2013 time period. The number of datasets used in this study provides opportunities to better understand the timing and causal mechanisms of wetland loss, which are critical for forecasting landscape changes in the future.

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RISK COMMUNICATION AND SEA LEVEL RISE ADAPTATION IN NORTH CAROLINA: PERCEPTION AND POLICY

One of the most significant challenges in addressing sea level rise (SLR) in many coastal communities is understanding and engaging with the variety of risk perceptions that exist among stakeholders. Many people involved in planning and decision-making do not have scientific backgrounds, yet scientists, planners and managers need to communicate complex information, such as projected rates of change and the potential for impacts to natural and human-built infrastructure that involve significant uncertainty. For effective risk communication, scientific information must be appropriately framed, visually compelling and take into account prevailing risk perceptions and diverse viewpoints. Results of a study conducted in two small, low lying communities in coastal North Carolina identified problems that residents had in interpreting SLR information. A document-based evaluation approach was used to assess issue awareness, reaction to texts and images, and possible adaptation responses; and was supplemented by semi-structured interviews with community leaders. Most people (88%) reported that they learned new information from documents, but they expressed substantial difficulty understanding information about SLR. The inability to decipher and understand information in sample documents was exacerbated by attitudes and beliefs about environmental change including fear, skepticism, fatalism, and loss. Perspectives among local officials also varied, suggesting that people serving communities in different capacities may have conflicting views on economic and infrastructure issues related to SLR adaptation. Such diverse perspectives have led to an on-going policy conflict between scientists and managers anticipating SLR and coastal development interests worried about the economic impact of adaptation policies. An empathetic, audience-driven communication strategy is more effective in promoting understanding and may make discussions of adaptation strategies more productive.

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MODELLING BIOTA-SEDIMENT INTERACTIONS IN ESTUARINE ENVIRONMENTS

Future choices about the realization of hydrodynamic infrastructures in estuaries should be based on solid forecast about the changes they will generate in the environment. While

complex numerical models are available for simulating sediment transport on physical basis, biologic elements are still hard to predict. This research project is aimed towards the integration of physical and biological insights in sediment transport models. As first step, we modeled the macrozoobenthic species spatial distribution in estuarine environments (SW Delta - The Netherlands) as function of those environmental variables that are relevant for sediment transport. As second step, we measured in laboratory conditions the effect of several macrozoobenthic species on sediment erodability. These observations describe ecological processes but are based on physical parameters. They can be used to parametrize semi-empirical models of biotic-mediated sediment dynamics, thus accounting for the biotic-induced deviations of sedimentary processes from purely physical expectations. As third step, we used our model to study the eco-morphological evolution of the SW Delta after the realization of a massive coastal defence plan (Delta Works). This project is part of the innovative program Building with Nature (www.ecoshape.nl).

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DIFFERENT FEEDING IN THE LARVAL AND ADULT STAGES OF AN INTRODUCED COPEPOD DETECTED BY DNA-BASED IDENTIFICATION OF PREY IN THE GUT

Introduced copepods are a dominant component of the San Francisco estuary, but characterization of their role in the foodweb is complicated by lack of information on feeding by the abundant larval stages (nauplii) in populations. Nauplii are smaller and have less developed appendages than adults, suggesting they rely on different food sources. We developed a method to identify prey by sequencing DNA from the guts of field-collected nauplii. The method involves screening for many types of prey with universal primers in a single polymerase chain reaction while blocking amplification of predator DNA. We applied the technique to *Tortanus dextrilobatus*, a predatory copepod introduced to the San Francisco estuary from east Asia in the early 1990's. In *T. dextrilobatus* adults, we detected DNA of other copepods, consistent with reports from previous laboratory feeding experiments. In contrast, nauplii contained DNA of cryptophytes, dinoflagellates, diatoms, rotifers, and larger zooplankton, including other copepods. Larval and adult *T. dextrilobatus* occupy different but overlapping feeding niches, a pattern that may be expected for other copepods that are carnivores as adults. These results demonstrate that a non-native species can play a different role in the introduced range at different stages of its life, both as a consumer and as a source of nutrition for other organisms.

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USING SCIENCE TO INFORM THE DURATION AND FREQUENCY OF NUMERIC NUTRIENT CRITERIA

Anthropogenic nutrient pollution is a major stressor of estuarine and coastal ecosystems around the world. In the US, the Clean Water Act (CWA) provides a regulatory framework for management of nutrient pollution that includes development of water quality criteria that set protective limits for pollutants sufficient to protect the waterbody. Recognizing that pollutant concentrations exhibit temporal and spatial variability, criteria under the CWA specify not only a concentration threshold or "magnitude," but a duration and frequency of exceedance that is not expected to affect aquatic life within the waterbody. Deriving the duration and frequency component of numeric criteria is especially challenging in the case of nutrients because (1) natural variability of nutrient concentrations is often complex relative to other pollutants and (2) nutrients are not directly toxic, but instead impact ecosystems via primary and secondary eutrophication responses such as increased primary production and hypoxia or seagrass loss, respectively. A brief overview of a framework and approaches used to compute the duration and frequency of numeric nutrient criteria will be discussed based on recent policy experience. Given increased interest in developing numeric nutrient criteria to support regulatory management of nutrient pollution in estuaries and coastal waters, there is a need for additional research to support efforts to compute the duration and frequency components of numeric nutrient criteria that takes into account both environmental needs of nutrient sensitive taxa, as well as hydrological characteristics of specific waterbodies.

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WATERSHED MASTER PLAN FOR FRESHWATER WETLANDS WILL IMPROVE COORDINATION OF WETLAND SCIENCE, POLICY AND MANAGEMENT: A CASE STUDY FROM TAMPA BAY, FLORIDA

This project presents a coordinated approach and partnership between federal, state, and local wetland regulatory agencies, and potentially private mitigation banks and land managers, that will help focus freshwater wetland compensatory mitigation activities to priority sites and/or habitats within the Tampa Bay, FL watershed. The Tampa Bay Estuary Program (TBEP) has developed quantitative restoration and protection goals for tidal wetland habitats in Tampa Bay as part of its Tampa Bay Habitat Master Plan and is now extending this effort to freshwater wetlands. Highlighting interconnectedness of coastal and upland habitats, as well as the role that freshwater wetlands play in providing ecosystem services (e.g. nutrient attenuation) to the estuary, is a key project goal. Mapping and change analysis of current (2007) and historical (1950s) wetlands for six categories within the ~5,500-square-kilometer watershed were performed. Wetland screening criteria were then applied to develop restoration and protection goals for individual drainage basins used by wetland permitting agencies. Restoration targets, as well as a decision matrix for permitting agencies, were incorporated into an overall watershed management approach. The project then developed a master plan between all partners that outlines strategies for the development of a coordinated linkage between publicly-funded land preservation and habitat restoration programs, and regulatory-required mitigation activities performed by private entities. The goal is to direct mitigation and restoration of freshwater wetlands towards areas and wetland types that will provide the most ecological benefit within the watershed, whether it is to support specific plant or animal species or to provide ecosystem services such as water quality improvement. Applying science-based selection criteria will result in more beneficial mitigation and restoration of freshwater wetlands while supporting economic development.

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ONE IF BY LAND, TWO IF BY SEA: NEARSHORE AND OFFSHORE DRIVERS OF HYPOXIA IN COASTAL ZONES

Scientific and public awareness of hypoxia as an issue in coastal ecosystems began with symptoms apparent in estuaries and shelf ecosystems. Low oxygen concentrations were thought to be driven primarily by nutrient enrichment from watersheds and atmospheric sources. As more scientific attention was drawn to these issues, reports of hypoxia and "dead" zones have increased dramatically. Researchers have examined drivers of hypoxia as well as impacts on the distribution, growth, and ecological interactions in affected systems. In the past 10 years, more reports have surfaced in upwelling ecosystems of subtidal hypoxia-driven kills of benthic marine organisms including abalone and urchins. The evidence for the California Current is that this may be a coast-wide phenomenon related to the shoaling of the oxygen minimum zone, leading to hypoxic events unprecedented for the last 60+ years. Both nearshore and offshore drivers of enrichment and hypoxia may be exacerbated by climate change which is likely to lead to increased stratification and thus less mixing. Evidence from Southern California Bight and the Oregon coast indicate it is likely that both shoaling of the OMZ and nearshore nutrient inputs could contribute to the observed patterns of hypoxia in at least some regions of the California Current. Hypoxia is one of a suite of symptoms including ocean acidification and warming that combine into what I refer to as climate change syndrome. Scientists and decision makers need to consider the cumulative and interactive impacts of these shared symptoms in order to support sustainable management of coastal ocean resources and ecosystems. Improved observational systems and modeling of the biophysical dynamics should aid our understanding of these dynamics and pathways to solutions.

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THE IMPACTS OF EUTROPHICATION ON ESTUARINE BIRD POPULATIONS OF LONG ISLAND, NY

Predatory bird populations are representative of the upper trophic levels in ecosystems, and are often sensitive indicators of ecosystem function. While sea bird reproductive success has been related to natural plankton blooms that support their prey species, the interaction of seabirds with anthropogenic nutrient sources in estuaries is unclear. Some possible interactions were investigated along the shorelines bordering Long Island, New York, USA, a heavily populated urban to suburban region. Data from the New York State Breeding

Bird Atlases and the Long Island Colonial Waterbird Surveys were compared with water quality data from the same region. Water quality data from several sources were converted to comparable units and spatially interpolated using ESRI ArcMap. The grid system used in the breeding bird atlases was superimposed over the interpolated nutrient data. The estimated mean nutrient levels in the water within the grid cell was used to represent nutrient levels within the cell. Both the estuarine bird diversity and the breeding pair numbers within cells were then compared with the nutrient levels using statistical methods. Breeding bird diversity was not negatively correlated to the nutrient levels within the value ranges of Long Island for both breeding bird atlases. Changes in diversity patterns may have also reflected changes in nutrient levels between the two survey periods. Spatial trends were seen in the total breeding pairs of various estuarine birds found within the grid cells during the colonial bird surveys. These results seem to support published associations between the breeding success of upper trophic level sea birds to natural phytoplankton blooms. These results may also lend support to reported negative effects to some upper trophic level species that has been associated with nutrient reductions.

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SEASONAL AND SPATIAL DRIVERS OF ESTUARINE BACTERIAL COMMUNITY COMPOSITION: A COMPARISON OF THREE ESTUARIES

Bacterioplankton are central to the functioning of estuarine and river plume ecosystems by mineralizing organic matter, recycling nutrients, catalyzing several critical biogeochemical reactions, and contributing to microbial food webs. Estuaries and river plumes are populated with marine bacterioplankton similar to those in the coastal and open ocean and yet temporal patterns in the composition and function of these communities often correlate with seasonal cycles in upslope freshwater and terrestrial environments. These seasonal fluctuations include variations in the rate of freshwater flow and the quantity and forms of organic matter and nutrients delivered by freshwater. Such external factors combine with local seasonal factors including ice formation, hypoxia/anoxia, and local (marine) production of organic matter to establish repeating environmental conditions that appear to drive annually recurring patterns in bacterial community composition. This presentation will compare three contrasting estuarine environments – the coastal lagoons of the Beaufort Sea, the Chesapeake Bay, and the Columbia River estuary. These systems are differentially impacted by external and internal environmental drivers and yet, in each system, bacterial community composition tracks seasonal patterns of environmental conditions. We will discuss the predictability of seasonal estuarine microbiomes and the relative importance of terrestrial seasonal cycles in controlling estuarine bacterial diversity and function.

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EXAMPLES OF MENTORING SUCCESS IN THE MARINE SCIENCES PROGRAM AT SAVANNAH STATE UNIVERSITY

Savannah State University (SSU) has developed several mentoring programs for undergraduate and master's students that are part of a unique circular pattern of outreach and student engagement that may be more effective than a linear pipeline. Many of these programs focus on a multi-level approach in which undergraduates are helped by each other, by graduate students, and by faculty. Our NSF GK12 program provides an opportunity for master's students to teach in the K12 classroom for a year. That effort, in turn, may encourage more students to remain in science. Our various outreach efforts have brought some freshmen into Savannah State. Our NSF REU program is designed specifically for students that have not yet had another opportunity for research. Furthermore, our NSF OEDG program is designed to enable undergraduates to participate in an oceanographic cruise just days after starting their college career and participate in a range of internship opportunities. This provides both informal and formal avenues for them to meet graduate students and faculty mentors. Our NSF GK12 program and Department of Education Title VII grant provide support for graduate students while offering opportunities for outreach—thus completing our circle. Funding through NOAA and NSF has provided opportunities for K12 teachers to participate in summer research at Savannah State University, while in turn sharing their expertise in science communication with their labmates. Through these efforts, we have demonstrated success in retaining underrepresented students in the geosciences and have increased the number of African Americans with master's degrees in marine science.

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FROM CHARISMATIC MEGAFAUNA TO PARASITES: INCORPORATING SCIENTIFIC RESEARCH INTO K12 ACTIVITIES

The creation of educational activities based on scientific research helps disseminate information to a wider audience and allows students to be engaged in the work. In addition, students who utilize actual data are able to apply mathematics, science, and geography to real-world situations. We created several K-12 interdisciplinary activities based on cetacean research methods. In one activity, students used data from sightings of common bottlenose dolphins, Tursiops truncatus, to calculate association indices. The students then hypothesized about the relationships of the dolphins based on the derived association indices and the background information provided on social bonds. The second activity focused on analyzing the spatial patterns of cetaceans. Students mapped sighting locations of common bottlenose dolphins using latitudinal and longitudinal coordinates and then examined the data for spatial patterns. We also designed an activity to teach students about marine mammal communication and vocal mimicry. In particular, we played recordings of dolphin whistle mimicry and then implemented an interactive activity in which students attempted to imitate the whistles, which we recorded and discussed. Visually impaired students listened to examples of vocal mimicry and were able to differentiate small variations in the whistles. Lastly, parasite research was incorporated into several K12 activities. We described the role of parasites in influencing host behavior and food webs. We also devised an activity that demonstrated the value of estimation. K-12 activities based on actual research can increase the reach of scientific findings, improve ocean literacy, and enhance educational opportunities for students. The quality of these activities was strengthened because of collaborations among scientists, NSF GK12 fellows, teachers, and informal educators.

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VARIABILITY IN SALT MARSH BIOMASS: ELEVATION RELATIONSHIPS: IMPLICATIONS FOR MODEL PREDICTIONS OF SLR RESPONSE AND C SEQUESTRATION

The relationship between marsh aboveground and belowground biomass is an important parameter in models predicting the response of marshes to projected rates of sea level rise (SLR). Both parabolic and linear relationships have been reported in the literature, and the Marsh Equilibrium Model (MEM) utilizes a parabolic relationship to predict the 'tipping point', or combination of marsh surface elevation and SLR rate, at which a marsh can no longer sustain itself. We obtained in situ measures of this relationship using elevation benchmarks in both fringing marshes and planar marshes with differing tidal amplitudes. The in situ parabola obtained from fringing marshes exhibits a lower optimal elevation than that from mesocosms, and extends across a broader elevation range than that from planar marshes. Differences in marsh location (edge vs. interior), wave energy setting, and tidal amplitude alter the relationship of aboveground and belowground biomass with marsh surface elevation. The root:shoot ratio also varies with elevation and site characteristics. We use the MEM to demonstrate the consequences of these differences in predicting marsh sustainability and marsh C sequestration potential under a variety of SLR scenarios.

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MULTIANNUAL VARIABILITY OF SEDIMENTATION ON MUDFLATS IN A MACROTIDAL ESTUARY (SEINE, FRANCE)

The objective of this study is to analyze the impact of hydrological variability, influenced by climatic phenomena, upon the sedimentary exchange between the turbidity maximum (ETM) and a river mouth intertidal mudflat. This study, carried out over a period of ten years (1997-2006), is specifically focused on two extreme periods, a wet one from 2001 to 2002 and a dryer one from 2005 to 2006. This study is based on an original approach, combining data gathered via low-altitude remote sensing with altimeter readings and ground-level measurements. Our results show that, during this ten-year period, we observed a reduction

of the mudflat surface (lower portion of the intertidal mudflat) by 32.3% (equivalent to 1.33 km2). These modifications are connected to the multiannual variability of hydrological flow rates which control the positioning of the turbidity maximum, source of the sedimentary material deposited in this intertidal zone. During wet periods, sedimentation rates increase by + 17 cm.y-1, while during the dryer one (when the turbidity maximum is located upstream of the estuary) we observed an erosion rate of -7.6 cm.y-1. Sedimentary deposition events in the mudflat resulting from spring tides are less frequent during dry periods, and they deposit a smaller quantity of sediment (-23% of total deposit mass per event). Due to lower flow rates coupled with the impacts of local development, flood currents have become dominant. It contributes to bring sandy or silty sediments on the mudflat of which the slope has increased 350% over 8 years, due to erosion. However, the saltmarsh-mudflat boundary (upper zone) is less affected by these hydrodynamic modifications.

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READING THE SIGNATURES OF BIOLOGIC-GEOMORPHIC FEEDBACKS IN THE TIDAL LANDSCAPE

When you look across the tidal landscape can you see the signatures of biogeomorphic feedbacks? Field evidence and the numerical results obtained by using a suite of biomorphodynamic models, ranging from point to 2D modeling approaches, utilizing progressively more realistic and detailed formulations, highlight the role of two-way feedbacks between physical and biological processes in shaping tidal landscapes. The interplay between physical and biological processes in tidal landscapes generates some striking biological and morphological patterns at different scales. At the large scale, marshes, tidal flats and sub-tidal areas form the basic patterns; whereas at a smaller scale, zonation patterns, a mosaic of bounded and nearly homogeneous vegetation patches, are ubiquitous salt-marsh features worldwide. We emphasize that biota acts as a landscape constructor feeds back on, directly alters, and contributes to shape tidal environments. Finally, we show how biogeomorphic feedbacks critically affect the response and the resilience of tidal landscapes to changes in the environmental forcing such as increasing rates of sea level rise and sediment supply.

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SUBTIDAL BAY CLAM POPULATIONS IN TILLAMOOK BAY, OREGON: COMPARISON TO INTERTIDAL POPULATIONS AND IMPLICATIONS FOR SHELLFISH MANAGEMENT

Tillamook Bay supports one of the most popular recreational clamming areas in Oregon targeting four species – *Clinocardium nuttallii*, *Tresus capax*, *Saxidomus gigantea*, and *Leukoma staminea* – commonly called bay clams. In addition, over two-thirds of the commercial bay clam harvest in Oregon comes from Tillamook Bay. The subtidal areas of the bay support a limited commercial dive bay clam fishery but, more importantly, are thought to serve as a refugia for adult bay clam populations providing a brood stock to re-seed the intertidal areas. In 2012, ODFW conducted a comprehensive randomized survey of subtidal bay clam populations in the major tidal channels of Tillamook Bay designed to complement intertidal surveys conducted in 2010-2011. The results of the survey indicated that a fairly small area of the subtidal (<100ha) supports significant bay clam with abundances and biomass 5-7 times greater than those found in the intertidal areas of the bay providing support for the subtidal broodstock concept. The biomass estimates from this study were comparable to previous subtidal surveys from the 70s, 80s, and 90s indicating a multi-decadal persistence of these populations. The presence of large subtidal populations in Tillamook Bay may be habitat-driven with the highest densities and biomass associated with the gravel-cobble habitats common in the lower bay relative to the unconsolidated sand or mud bottoms which occur in isolated channels or up-bay locations. Interestingly, the habitat requirements for some species differs for the subtidal and intertidal populations implying that multiple habitat types should be managed/protected to maintain clam populations in the bay. The presence and importance of a subtidal broodstock for bay clam populations is still an open question for Oregon estuaries but, at least for Tillamook Bay, may explain the high levels of intertidal clam harvest that have been supported for more than 50 years.

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UREA CYCLING IS IMPORTANT TO NITROGEN DYNAMICS IN THE NORTHERN GULF OF MEXICO

Urea and ammonium (NH4+) dynamics were compared in 15N isotope-enrichment experiments conducted on seawater collected from four depths at three sites in the northern Gulf of Mexico, in May 2012, to consider the relative importance of urea and NH4+ cycling to internal N cycling in this region. The sites included a eutrophic station near the Mississippi River mouth (MRM), a well-studied hypoxic site (C6), and a more offshore control station (NC). The concentrations and isotope ratios of urea and NH4+ in sea water, enriched respectively with 15N-urea and 15N-NH4+, were determined by NH4+ isotope retention time shift high performance liquid chromatography (AIRTS-HPLC), before and after 24-h incubations. The "actual" regeneration (Reg) and "potential" uptake rates (Upt) were lower for urea than NH4+ on average at the different depths but values were comparable, suggesting that urea cycling is important to N dynamics in this region. Hypoxia had no obvious effects on urea dynamics. For example, urea Reg and Upt rates were 0.011±0.002 and 0.025±0.006 μmol-N L-1 h-1, respectively, in near-bottom water at the hypoxic C6 site (Dissolved Oxygen [DO] = 1.3 mg L-1), and similar to rates observed in oxic regions. Potential degradation rates of added 15N-urea, as evidenced by 15NH4+ accumulation during 24h incubations, were quite high (50-90 %) relative to natural NH4+ regeneration rates at NC with low chlorophyll α (Chl α), intermediate at C6 (<10 to 50%), and unimportant (<10%) at MRM with high Chl α concentrations. Light effects on urea cycling rates were inconclusive, except for MRM where UPt values for urea were clearly higher in light than dark incubations. Overall, we conclude that internal urea cycling by organisms is an important component of water-column N-dynamics in the Mississippi River plume region.

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EFFECTS OF ONTOGENY ON BIOREMEDIATION CAPACITY OF OYSTERS

Oyster restoration and aquaculture may benefit coastal ecosystems by remediating the effects of anthropogenically-driven eutrophication through sequestering and removing nitrogen (N). N stored in phytoplankton and other suspended particles is removed from the water column by suspension feeding bivalves such as oysters (Crassostrea virginica) and assimilated into tissues. Additional N removal may occur indirectly through biogeochemical processes stimulated by oyster biodeposition. The magnitude of this ecosystem service has been rarely documented with direct measurements, and previous estimates have not accounted for differences due to ontogeny. To quantify the role of oysters in improving water quality and test the effects of ontogeny on N removal, this study compared direct N removal via assimilation into tissues and potential for indirect N removal via oyster biodeposits through time in juvenile and adult oysters. Juvenile oysters grew throughout the study and assimilated 68 ± 6 mg N oyster-1 while adult oysters did not actively assimilate N. Total N released in biodeposits was 0.35 ± 0.02 mg N oyster-1 at a mean rate of 19.4 ± 1.1 μg N oyster-1 hr-1 and did not differ between age classes. These results demonstrate that ontogeny (and associated growth status) can mediate N removal by tissue assimilation, and may be uncoupled from biodeposition and resulting biogeochemical N removal. For continuous N sequestration and removal, oyster aquaculture or restoration projects will benefit from balancing oyster growth and harvest to support recruitment of new young actively growing oysters and removal of older animals before growth substantially declines.

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NITRIFICATION AND AMMONIA-OXIDIZING MICROBIAL COMMUNITIES IN THE TURBID, NUTRIENT-REPLETE WATERS OF SAN FRANCISCO BAY (CA)

Microbial ammonia oxidation, the first step of nitrification, provides a link between nitrogen (N) inputs from remineralization and losses via denitrification, and thus plays a critical role in regulating estuary productivity and nutrient export. The discovery of ammonia-oxidizing archaea (AOA) has led to a proliferation of research on the microbial ecology of this process, and AOA, rather than the well-studied ammonia-oxidizing bacteria (AOB), appear to be the dominant ammonia oxidizers in many ecosystems. Estuaries, however, confound this pattern: some harbor thriving AOA communities, while AOB outnumber AOA in others. Understanding the biogeochemical roles of these two groups is essential for understanding N cycling in estuaries, which frequently receive and process high anthropogenic nutrient loads. Yet, few studies have analyzed ammonia-oxidizing communities or nitrification rates in estuarine waters. This study characterized the pelagic ammonia-oxidizing communities and nitrification rates in San Francisco Bay (CA), the largest estuary on the North American west coast, focusing on the polyhaline regions of Central and South Bay. Nitrification rates ranged from <10 to >200 nmol L^{-1} d^{-1}, and were highest in the sediment-rich waters of Lower South Bay and the estuary turbidity maximum. AOB generally outnumbered AOA

by about two orders of magnitude, as measured by group-specific *amoA* gene abundance; *amoA* mRNA transcript abundance also suggested higher AOB activity. Interestingly, nutrient fluctuations driven by the South Bay spring phytoplankton bloom led to dramatic oscillations in AOB populations, while AOA maintained a constant low abundance throughout our sampling, suggesting distinct niche differentiation between AOA and AOB in San Francisco Bay. This study provides a framework for understanding the dynamics and impacts of microbial N cycling in the waters of this turbid, nutrient-rich estuary.

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CARBON SEQUESTRATION OF MANGROVE FLATS IN ELEUTHERA, THE BAHAMAS

An approach to mitigating rising atmospheric carbon dioxide levels is to conserve and restore natural ecosystems that sequester the most carbon at the fastest rates. Ecosystems that may have great potential to store carbon are coastal ecosystems such as mangrove flats, salt marshes, and seagrass beds. In the short term, these ecosystems sequester carbon in the plant biomass, while sequestering carbon in the sediment for the long term. Early work suggests that these “blue carbon” sinks may store more carbon than terrestrial ecosystems, but more information is needed about the role of these ecosystems in the global carbon cycle. Our primary objective was to determine how carbon is sequestered in mangrove flats dominated by Rhizophora mangle in the Bahamas specifically determining how much carbon is stored, the rate it is sequestered and what influences its storage. In January 2013, we began our long-term sequestration study by selecting 4 study sites near the cape of Eleuthera, which were chosen to maximize variability between sites. All sites lack any definitive freshwater source and seem influenced by tidal inputs. Sedimentation will be quantified over time and samples will be extracted yearly for carbon analysis. Nondestructive sampling techniques will be utilized to determine carbon storage in plant biomass. Carbon content will be determined from biomass estimates that were extrapolated from volume estimates based on growth parameters measured in the field. Growth rates will be derived from internode measures over time, while yearly carbon sequestration rates will be determined from Rhizophora growth rates and sediment accumulation. Preliminary results suggest that carbon sequestration is variable from site to site and that it is influenced by tidal inputs. When more is known about the factors that influence carbon sequestration, then these elements can be taken in consideration when restoration efforts are attempted.

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HYDROLOGIC CONNECTIONS AND LANDSCAPE METRICS TO ADVANCE ECOSYSTEM GOODS AND SERVICES IN THE TAMPA BAY WATERSHED

Understanding the hydrological characteristics of coastal wetlands across land use gradients ranging from natural to urban to agricultural is important for significantly enhancing our ability to utilize environmental data in interpreting ecosystem condition and processes. Here we demonstrate the utility of continuous water level recorder data from 27 wetland sites distributed in the eastern Tampa Bay, Florida watershed. When combined with geospatial, and hydrologic connectivity analysis, these data provide critical context for enhancing analysis of experimental and analytical designs. These approaches are presently used to support efforts to quantify ecosystem services (e.g., nutrient processing, carbon sequestration, water storage) in coastal wetlands. With these hydrological and landscape building blocks, we have the ability to compare site-specific, landscape type, and habitat type hydrology to other measured parameters to determine the relative production of ecosystem service potential. Ultimately, this project aims to create spatial representation of ecosystem goods and services incorporating hydrological connectivity in order to improve assessments of ecosystem goods and services for use in resource management and community planning decisions.

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CHARACTERIZATION OF MICROBIAL CARBON CYCLERS IN A SOUTHERN CALIFORNIA SALT MARSH USING DNA STABLE ISOTOPE PROBING

Carbon cycling by microbes has been recognized as the main mechanism of organic matter decomposition and export in wetlands, yet very little is known about the roles of specific groups (e.g. bacteria) in salt marsh benthic trophic structure. Indeed, salt marsh sediment microbes remain largely in a black box, not only in terms of diversity but also in their functional roles within salt marsh benthic food web pathways and associations with other trophic levels. We used traditional stable isotope analysis and DNA stable isotope probing (SIP) to evaluate the fate of microalgal- and macrophyte-derived carbon into both the invertebrate and bacterial salt marsh benthic communities. Overall, 146 bacterial species were detected using SIP, of which only 12 lineages were shared by both enriched and non-enriched communities. Bacteria from the 13C-labeled community include Desulfosarcina, Spirochaeta, and Kangiella. Enrichment experiments revealed large contributions of microalgal-derived carbon and small contributions of Spartina foliosa-derived carbon to the diets of sediment invertebrates. Invertebrate exclusion experiments showed that organisms without direct access had a slightly elevated δ15N signature, suggesting small amounts of decomposed S. foliosa-derived carbon are liberated via microbial mediation. This study was the first to use heavy labeled lignocellulose to identify microbes responsible for macrophyte utilization in salt marsh sediments and will allow future studies to target specific lineages to elucidate their role in salt marsh carbon cycling.

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WATER FLOW AND SEAGRASS SEED DISPERSAL: COMPARING SEED MOVEMENT FOR SPECIES WITH DIFFERENT REPRODUCTIVE STRATEGIES

The effects of water flow on seagrass productivity have been studied at length, but the effects of water flow on seagrass seed dispersal have largely been ignored. Using a recirculating flume, we examined the influence of water speed and wave height on seed movement for two sub-tropical seagrass species with differing reproductive strategies: turtle grass (Thalassia testudinum), whose large seeds (7.65 ± 0.09 mm tall) are suggested to have the potential for long distance dispersal, and shoal grass (Halodule wrightii), whose small seeds (2.11 ± 0.06 mm) are likely retained near the parent plant. Turtle grass seeds initiated movement at 7.20 ± 0.51 cm s-1 and a wave height of 4.28 ± 0.38 cm, whereas shoal grass seed movement began at 10.5 ± 0.37 cm-1 and 5.20 ± 0.00 cm, respectively. Turtle grass seed speed and distance traveled exceeded shoal grass seed movement at all flow speeds and wave heights tested. Results from this study suggest that water flow can influence dispersal of sub-tropical seagrass seeds, but the dispersal dynamics are species-specific and likely related to seed morphology.

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ARE STABLE ISOTOPES ALONE SENSITIVE ENOUGH TO TRACE SMALL-SCALE EFFECTS OF LAND-USE CHANGE?

Carbon and nitrogen stable isotope ratios ($\delta^{13}C$ and $\delta^{15}N$) are increasingly used as tracers of organic matter sources to estuarine watersheds and to define the influence of pollution sources on estuarine processes and food webs. While stable isotope ratios are established as useful tracers of wastewater sources to estuaries, it is not clear that these ratios are sensitive enough to trace smaller, non-point sources particularly under incipient levels of land-use change, because source isotopic signatures may overlap. We conducted an 18-week manipulative field experiment using cages of transplanted oysters at 9 shallow estuarine sites in coastal MS where there are no known point wastewater discharges, to define the effects of non-point and transient or incipient organic matter source shifts on $\delta^{13}C$ and $\delta^{15}N$ values in oyster tissue. To assess the utility of stable isotopes to predict the effects of small-scale land use change at the ecosystem level (in a primary consumer), we measured SI ratios alongside fecal indicator microbes in water and oyster tissue and dissolved nutrient concentrations in water. N and C SI ratios in oyster tissues were positively correlated, except at the two most urbanized sites where $\delta^{15}N$ values were higher than predicted by relationships at the other sites. $\delta^{13}C$ varied between up- and downstream locations in each bayou, reflecting generally greater terrestrial influence at upstream sites. Fecal indicator concentrations were also higher at the more urbanized and $\delta^{15}N$ enriched sites, highlighting the influence of non-point

sewage inputs and possibly greater microbial processing of organic material at these sites. These findings confirm the ability of stable isotopes to indicate early ecosystem level effects of N source shifts in estuaries and point out that SIA can be strengthened by tandem use of additional tracers, particularly for tracing wastewater influence.

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LIVING SHORELINE IMPACTS BENTHIC BIOMASS IN A BEFORE-AFTER-CONTROL-IMPACT STUDY

Recently, studies examining the effects of shoreline development on near-shore systems show decreases in biomass, density, and diversity of benthic organisms and fish adjacent to developed shorelines compared with natural shorelines. To reduce the negative impacts of shoreline development on near-shore systems, researchers and coastal developers have begun to incorporate natural design elements, such as offshore breakwaters along with planted marsh grass, referred to as living shorelines. We employed a before-after-control-impact (BACI) study, comparing linear models, to assess the impact of shoreline development on biomass, density, and diversity of near-shore communities in the Corsica River, a subtributary of the Chester River, Chesapeake Bay. In summer 2010, 152 m of straight bulkhead was replaced by 309 m of living shoreline, including tombolos, offshore breakwaters, planted marsh grass, and downed trees. We sampled benthic infauna and the Blue crab Callinectes sapidus, and characterized the sites (sediment grain size, DO, temperature, and salinity) at the impacted shoreline and two sets of control sites before the change and one and two years after it, in summer 2011 and 2012. Sediment grain size decreased in 2011 at change sites, indicating a change in habitat. Benthic biomass and density and decreased at control and impacted sites in 2011, but diversity decreased only at the impacted sites. However, biomass and density greatly increased in 2012 at the impacted sites. Blue crab density was low overall and showed little temporal change. The results of this study show the benefit to the benthic community in adopting living shoreline techniques to prevent erosion, and the ability of shoreline changes to cause long-lasting, fundamental changes in the benthic habitats. Living shorelines have the added benefit of increasing habitat complexity along with the ability to protect from erosion and potential to adapt with sea level rise.

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NUTRIENT ENRICHMENT EFFECTS ON ROOTS, RHIZOMES, AND PEAT IN A SYSTEM DOMINATED BY SEDIMENT DEPOSITIONAL PROCESSES

We examined belowground structure in coastal marshes of the North Inlet Winyah Bay system, a National Estuarine Research Reserve (NERR) in South Carolina, USA. In this observational study we included the Debidue Creek (located approximately 1 km south of a 40 year old residential development) and Goat Island (a site with an ongoing longterm fertilization experiment) to examine belowground structure of roots, rhizomes, and peat using CT imaging. We observed a significant increase in coarse roots, rhizomes, and peat associated with 12 years of fertilization (nitrogen and phosphorus) at Goat Island. The upper Debidue Creek station was located adjacent to an oyster reef that had been receiving residential wastewater effluent since the 1970s. This station had significantly fewer coarse roots and rhizomes compared to the belowground structure of the marshes at the mouth of the Debidue Creek. Although there were fewer rhizomes in the upper Debidue Creek, the diameter of the rhizomes was significantly greater in the upper Debidue than at the mouth, and twice the magnitude of the rhizomes observed at the 12 year fertilized Goat Island marsh. The peat at the upper Debidue had a significantly greater particle density and appeared more waterlogged with lower accumulation of organic matter than observed at the Debidue mouth. Our observations at the upper Debidue Creek are similar to CT images from disappearing Jamaica Bay marshes (NY), which also have received long-term effluent exposure (over seven decades). Twelve years of fertilization (i.e., at Goat Island) resulted in a buildup of coarse roots, rhizomes and peat in these minerogenic marshes, but long term (over 3 decades) effluent inputs may alter the below ground organic matter accumulation, resulting in fewer roots and rhizomes and more waterlogged peat (i.e., at upper Debidue creek).

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VARIATION IN JUVENILE CHINOOK SALMON DIET COMPOSITION AND FORAGING SUCCESS AMONG NATURAL AND DEVELOPED ESTUARIES IN THE PACIFIC NORTHWEST

Substantial alteration of estuaries by human development has reduced the capacity of these ecosystems to support outmigrating juvenile Pacific salmon (Oncorhynchus spp.). The primary mechanisms driving the reduced capacity are often assumed to be a reduction in rearing habitat and prey availability; however, the mechanisms are not definitively known. To help fill this knowledge gap we evaluate the effects of human development of estuaries on the diet composition and foraging success of juvenile Chinook salmon (O. tshawytscha). The foraging habits of juvenile salmon within estuaries have been extensively studied, in part motivated by evidence that successful foraging and rapid growth in the coastal environment is positively correlated with survival to adulthood. Many studies of fishes foraging in estuaries have compared diets of fishes along an estuarine gradient or among types of human development within a single estuary to determine how natural and anthropogenic habitat variation influences fish diet composition and foraging success. However, for mobile, opportunistic consumers such as juvenile salmon, a useful scale for comparisons of diet composition and foraging success may be between whole watersheds that differ in landscape attributes. To date, this scale of comparison has been underutilized relative to within-watershed comparisons, but is increasingly germane to restoration planning of estuarine habitat for salmon recovery. We compiled juvenile Chinook salmon diet data from multiple Pacific Northwest estuaries that vary in their extent of human development to evaluate the effects of anthropogenic modification of estuaries on juvenile Chinook salmon diet composition and foraging success. Specifically, we hypothesize that juvenile Chinook salmon will feed less on terrestrial and emergent insects in highly developed estuaries and that foraging success (ration size, energetic value of consumed prey) will be lower in highly developed estuaries.

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TROPHIC LINKS DRIVE HABITAT CONNECTIVITY FOR REEF FISH IN SUBTROPICAL COASTAL HABITATS

Functional connectivity among habitats is a focal concept for directing future coastal marine management, with many mobile marine species depending on resources in more than one habitat. Coral reefs and mangroves are highly productive habitats that are important for maintaining ecosystem health in tropical and subtropical waters. The degree of physical connectivity between coral reefs and mangroves positively influences reef fish abundances in the Indo-Pacific region. Carbon transfer across habitat boundaries can have major implications for population structure and food web dynamics, and a trophic link between reefs and mangroves is posited as a likely explanation for the higher fish abundances. Carbon may be exchanged passively by detrital transport or actively through the movement and feeding of animals; both mechanisms can be traced using stable isotope analysis. We tested whether mangroves provide trophic subsidies to a key species of roving herbivore (Siganus fuscescens) on coral reefs and whether this link was dependent on the level of connectivity between the two habitats. Using carbon isotopes of liver tissue from fish in Moreton Bay Marine Park, Queensland, Australia, we found that S. fuscescens depends on resources from mangrove habitats and that their dependence on these resources increases with increasing proximity of reefs and mangroves. We confirm that a trophic link drives connectivity between two major coastal habitats, thus strengthening our understanding of processes that support ecosystem based management in these areas.

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FRESHWATER INPUTS AND COASTAL PRODUCTIVITY IN THE PACIFIC NORTHWEST

The coastal ocean plays a key role in global biogeochemical cycles. In the Pacific Northwest, the coastal waters are strongly influenced by freshwater inputs from the Strait of Juan de

Fuca (fed by the Fraser River and the rivers of Puget Sound) and the Columbia River. These rivers act as a conduit for land-derived nutrients and as a facilitator for entraining ocean-derived nutrients into the coastal euphotic zone. Riverine delivery of nutrients to the coastal ocean may play an important role in winter and spring phytoplankton blooms along the Washington and Oregon coasts. In the Strait of Juan de Fuca, freshwater flow influences estuarine exchange, where deep, high-nutrient waters are upwelled from a submarine canyon and entrained into surface waters. Additionally, the Columbia River plume modifies flow on the shelf and can play a significant role in the retention and transport of phytoplankton communities along the coast. Here, we present results from a four-box (NPZD) model of planktonic nutrient cycling coupled to a high-resolution circulation model of the Washington and Oregon coasts developed as part of the PNWTOX (Pacific Northwest Toxins) Project. Specifically, we consider a numerical simulation of the year 2005 forced with realistic bathymetry, tides, and climatology with a special model case in which we turn off the Columbia, Fraser, and Puget Sound rivers to examine the role of freshwater inputs on regional patterns of phytoplankton biomass and productivity. Results from the biophysical model are also compared to physical, chemical, and biological data from two recently completed observational studies – The Ecology and Oceanography of Harmful Algal Blooms in the Pacific Northwest (ECOHAB) and River Influences on Shelf Ecosystems (RISE).

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MULTI-SCALE INVESTIGATION OF ABOVEGROUND BIOMASS RESPONSE TO AGRICULTURAL DENSITY IN COASTAL MARSHES

This study assessed multi-scalar ecological processes and how their interactions can influence large and small-scale coastal marsh patterns over time. A spatial-temporal understanding of how variations in agricultural density might affect adjacent marshes is needed to correctly assess the potential of eutrophication and marsh degradation since initial analyses suggest a positive correlation of increased agricultural density and annual primary production (APP) of aboveground biomass. The study site, the Delmarva Peninsula, seems to have a related South-North APP gradient. Our objectives included identification and quantification of agricultural fields along the peninsula and determination of their density in relation to regional coastal watersheds. The analyses were carried out in a spatial-temporal context to identify potential relationships between agricultural density and APP in high-marsh areas. APP data records from 1999-2008 were statistically analyzed among 7 high-marshes. This data was correlated with the density of agricultural fields for each marsh's watershed using remotely sensed images. Analysis of the APP and the agricultural density per coastal watershed showed an inverse relationship over the 9-year study period. The potential deleterious impacts of high nutrient input and the confounding effects of herbicide use in the area may explain this relationship.

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AN ALLOMETRIC EQUATION FOR ESTIMATING ABOVEGROUND BIOMASS OF BLACK MANGROVE (*AVICENNIA GERMINANS* (L.) L.) SHRUBS IN THE NORTHERN GULF OF MEXICO

Black mangrove (*Avicennia germinans* (L.) L.), a woody shrub/tree, is a foundation species in saline wetland habitats in the northern Gulf of Mexico, forming dense mono-specific stands in competition with saline marsh species. It is a tropical species with some frost tolerance, allowing it to expand into saline marsh habitat at its northern range during periods of warmer than average winter low temperatures, changing the dynamics of biomass production and potential carbon sequestration. In contrast, colder temperatures significantly below freezing will damage black mangrove, sometimes mortally, and other times causing dieback with vigorous re-sprouting from the root base, forming low, multi-stemmed shrubs. We have been monitoring the spread of black mangrove at sites near the northern extreme of expansion in the Gulf of Mexico where vegetation plots may include shrubs as well as trees. Allometric equations provide a non-destructive method of estimating biomass and have been developed in South Florida and Mexico using trunk diameter and crown height to estimate biomass of black mangrove trees. However, these equations do not accurately predict biomass of the shrub form. We harvested plants in coastal Louisiana to develop an allometric equation for calculating biomass of black mangrove shrubs. We defined shrubs as individual plants, single-stemmed or multi-stemmed from the same root base, with a height range 30-140 cm. For each individual, we measured height, width and length of the crown, and diameter of the largest stem at a height of 30 cm. We then harvested the entire plant at the soil surface and measured oven-dry weight. The two-dimensional crown area calculated from the measurement of width and length of the crown proved to be the best predictor of biomass, with a high linear correlation. We plan to use crown area to calculate biomass and carbon reserves of the shrub form of black mangrove as it expands into saline marshes in the northern Gulf of Mexico.

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TIDAL MOVEMENTS OF SACRAMENTO SPLITTAIL IN A REMNANT TIDAL MARSH

The Delta Stewardship Council's Bay Delta Conservation Plan proposes tidal marsh restoration as a central management strategy for enhancing populations of special status native fishes in the upper San Francisco Estuary. However, there is considerable uncertainty about the degree to which restoration sites will be used by native fishes, due to the limited baseline data available on fine-scale usage patterns in remnant tidal marshes. Time-series data from the Suisun Marsh Fish Study (1980-present) suggest that the 1,050-acre remnant tidal marsh, Rush Ranch, is relatively more abundant in juvenile life stages of key native fish species such as the Sacramento splittail (*Pogonichthys macrolepidotus*). We postulate that Rush Ranch's extensive networks of undiked intertidal channels, which provide corridors between subtidal sloughs and the vegetated marsh plain, provide favorable nursery habitat for splittail. Specifically, we hypothesize that tidal cycles influence splittail usage patterns, wherein splittail enter intertidal channels during flood tide events. Preliminary data collected from June-August 2013 confirms our hypothesis; however, splittail tend to enter during nighttime on new and full moons when tidal flooding is the greatest. In addition, we found that individuals re-enter the same channel on successive nighttime flood tide events. These results present the first recorded evidence of splittail fine-scale usage patterns within a remnant tidal marsh.

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AVIAN AND BENTHIC INVERTEBRATE RESPONSES TO EELGRASS AND NATIVE OYSTER RESTORATION THE SAN FRANCISCO BAY ESTUARY

The San Francisco Bay (SFB) Living Shorelines Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. Phase I includes using a pilot-scale, experimental approach to establish native oysters and eelgrass at two SFB sites in Hayward and San Rafael. We conducted avian and benthic invertebrate pre-project monitoring at each site from Nov 2011-Apr 2012, and post-project monitoring from Sep 2012 – Apr 2013. Our primary objective was to determine species and guild specific responses to restored habitat relative to control areas and pre-treatment conditions using a Before-After Control-Impact (BACI) design. We conducted high and low tide avian surveys twice monthly to record avian densities, instantaneous behavioral scans, and focal behavioral observations. To relate waterbird densities and behaviors to prey availability, we sampled invertebrates by taking 3 replicate benthic cores every 150-m along transects running perpendicular to shore. Both pre- and post-project avian densities were highest at Hayward treatment and control sites where small shorebirds predominated and reached densities of >2300 birds/ha during peak periods in January of both years. At San Rafael, densities of black oystercatcher and wader species increased significantly at treatment plots compared to pre-treatment and control densities. Bivalves predominated at Hayward and more than doubled in the treatment area during the post-project period. The number of unique taxa at the San Rafael site increased from 14 representing 6 classes to 22 representing 8 classes. Our preliminary results suggest that some avian and invertebrate species may be responding to oyster and eelgrass habitat restoration

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MISSISSIPPI RIVER INFLOW PROVIDES TROPHIC SUBSIDY TO THE FOOD WEB OF A LOUISIANA ESTUARY: NEW INSIGHTS USING SULFUR ISOTOPES AND ENERGY DENSITY OF NEKTON

The diversion of Mississippi River water into Louisiana estuaries is currently used as part of an effort to restore coastal wetlands. Reintroduction of Mississippi River water could alter estuarine foodweb pathways, and affect the energy density of estuarine fishes and invertebrates. We analyzed the isotopic composition and energy density of the same select group of consumers in an estuary receiving Mississippi River water from a freshwater diversion, an estuary closed off from this freshwater inflow, and an estuary naturally connected to Mississippi River inflow to determine the relationship between river connectivity and trophic subsidy. The goals of this study were to determine: 1) if the reintroduction of river water through a diversion has caused changes in the estuarine food web, and 2) if these foodweb changes have a positive effect on the energy density of nekton in the estuary. While studies have been performed in the freshwater portion of the estuary, it was of interest to us if a trophic subsidy effect of the freshwater inflow extends into the brackish waters of the estuary. Using δ13C, δ15N and δ34S, we determined that river-associated alterations in foodweb pathways were evidenced by an increase in the relative contribution of seston as the ultimate carbon source in the diets of estuarine nekton. The distinctive δ34S value of seston/phytoplankton versus other carbon sources (C3 plants, C4 plants, benthic algae, SAV, estuarine detritus) was instrumental in this conclusion. Calorimetry analysis indicated that energy density of nekton was positively correlated with the proximity of freshwater inflow. The energy subsidy was evident only up to about 20 km distance from the freshwater inflow. Our results indicate that a reconnection with the river alters estuarine foodweb pathways, and that the increase in the relative contribution of seston results in higher energy density of nekton close to the source of freshwater inflow.

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RESPONSE OF MACROBENTHIC COMMUNITIES TO VARYING LAND USES IN OSO BAY, CORPUS CHRISTI, TEXAS

Coastal systems are subject to stress stemming from both natural and anthropogenic disturbances. One disturbance, known as nutrient loading, supports algal blooms that affect populations living within oxygen deprived sediment. Oso Bay, Corpus Christi, Texas is a standing example of a marine system affected by excessive nutrient loading and can provide insight as to how nutrient loading may affect benthic communities. This study focuses on six sites in Oso Bay; five of which correspond to sources of anthropogenic runoff and include input from a wastewater treatment plant, an active and inactive golf course, residential areas, engineered stormwater, agricultural and industrial cooling water runoff. The sixth site is a site of continuous saltwater exchange between Oso Bay and Corpus Christi Bay. Beginning in February 2013, sediment samples have been collected monthly using benthic cores. Water quality parameters such temperature, salinity, and pH were measured concurrently. Temporal and spatial differences in macrobenthos were determined by comparing the species richness and abundance across the sites and amongst sampling dates. Preliminary results indicate strong seasonality among macrobenthos communities. Information on macrobenthos distribution spatial distribution across a gradient of varying anthropogenic inputs can help inform coastal resource management decisions.

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THREE-DIMENSIONAL DYNAMICS OF SEDIMENT TRAPPING IN TIDE-DOMINATED ESTUARIES, AN EXPLORATORY MODEL

Turbidity maxima, which result from the trapping of sediment by the joint action of tidal and residual currents, are common features in estuaries. Knowledge about locations and intensities of these turbidity maxima is important, as they affect navigation and ecology. To unravel the mechanisms that cause trapping of sediment, exploratory models have been developed and analyzed. These models primarily focused on dynamics in either along-estuary or cross-estuary transects. In this presentation, a new three-dimensional semi-analytical model will be discussed that governs tidal flow, residual flow, sediment transport and formation of mud pools in a tide-dominated estuary. The model will be specifically applied to the James River estuary and its results will be compared with available field data. Specific focus will be on the relative importance of different physical processes (advection, asymmetry in mixing) in generating estuarine turbidity maxima for different external forcing conditions, such as fresh water discharge and tidal range.

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MODULATION OF WATERSHED NUTRIENT LOADS BY TIDAL CREEK ECOSYSTEMS ON VIRGINIA'S EASTERN SHORE

While deeper estuaries typically demonstrate predictable responses to increased nutrient loads, responses in shallow systems are more varied. Shallow systems are particularly vulnerable to changing land use and concomitant increases in loads due to their position at the interface between land and open water. Virginia's Eastern Shore is characterized by shallow lagoons connected to upland watersheds through small tidal creeks, where the main source of fresh water is groundwater, making these systems particularly susceptible to changing land use, development pressure, and agricultural activities. While some studies have characterized response of these lagoons to nutrient loads, little is known about the tidal creeks and whether they act as filters or conduits for land-based nutrients. We examined the role of these creeks in modulating watershed nutrient inputs in the Machipongo River system, the largest tidal creek complex on the Virginia Eastern Shore, which drains to Hog Island Bay. Monthly monitoring using Dataflow was combined with seasonal determinations of water column and sediment metabolism, diel/tidal salinity and oxygen excursions, and tidal current velocity. Data were used to calibrate an intermediate complexity model of the creek-lagoon system that simulates major pools of carbon, nutrients and autotrophic biomass, as well as biogeochemical cycling of major nutrients. The model is being used to assess the degree to which tidal creeks export (via flushing) or retain/remove (via denitrification and benthic microalgal uptake) land-based nutrient loads, and the potential for changes in land use and associated loads to cause water quality impacts in the creeks and adjacent lagoons.

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HABITAT ASSOCIATIONS AND SHELTER USE BEHAVIORS IN THE CALIFORNIA SPINY LOBSTER, *PANULIRUS INTERRUPTUS*: ASSESSMENTS AT LANDSCAPE AND LOCAL SCALES

The California spiny lobster (Panulirus interruptus) is a gregarious, shelter-dwelling species whose distribution, abundance, and survival may be closely tied to habitat structure at a variety of scales. Lobster habitat associations are likely driven by behaviors that minimize predation risk while maximizing foraging opportunities. Here we report on the initial results of our collaborative project quantifying baseline levels and short-term changes in abundance, size distribution, movement, and behavior of P. interruptus within and outside of newly implemented marine protected areas (MPAs) in the South Coast Region of California. To link lobster density and behavior to benthic habitat features at landscape scales, and determine if these linkages vary across the South Coast region, we conducted SCUBA-based transect surveys of rocky reefs at ten sites (five within and five outside of MPAs) within southern California's most heavily fished coastal waters. Working at local scales, we conducted a series of tethering experiments to examine how relative survival of subadult lobsters varies under different shelter and social conditions. We found that lobster density and size are similar across sites, as well as inside vs. outside MPAs, and that lobster density is correlated with boulder cover and substrate relief. Most lobsters are gregarious, with 42% of lobsters found in aggregations of three or more. Proportional survival for solitary lobsters is highest for those tethered to shelters closely scaled to body size, indicating that shelter scaling may be an important antipredator strategy for subadults, as is true for other lobster species. We presently are assessing the relative benefit of aggregative shelter use and how the presence and size of conspecifics impact relative survival of subadults. Our data will provide more information about this ecologically and economically important species, and suggest whether P. interruptus may benefit from MPA establishment.

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FACULTY, GRADUATE STUDENT AND UNDERGRADUATE MENTORING RELATIONSHIPS THROUGH EXPERIENTIAL LEARNING IN MARINE SCIENCE/MARINE BIOLOGY AT A SMALL COASTAL CAMPUS: TEXAS A&M UNIVERSITY AT GALVESTON

Texas A&M University at Galveston (TAMUG) is the marine and maritime oriented branch campus of Texas A&M University. TAMUG has an enrollment of ~1900 undergraduates, with ~750 undergraduates and ~125 graduate students seeking degrees in marine biology, marine science, oceanography, and marine resource management. With 30 active research labs, involving undergraduates in field and lab-based research has been a significant and necessary part of our history. Because of our small size and the low ratio between

undergraduates and graduate students, much of our undergraduate mentoring occurs through our graduate students. The platforms for these mentoring relationships take many forms, including, undergraduate student workers in research labs, internships, senior and senior honors thesis research, research fellowships, and class laboratory courses and experiential research classes. An example of our experiential research classes is our Modern Oceanographic Field Methods class (MARS 460), a 5-credit field based class. Each year the class focuses on a different multidisciplinary research theme/site, for example in 2013 they investigated sediment and phytoplankton dynamics in West Galveston Bay. By working in teams of 3-4, they develop a semester long research project, write a proposal, conduct the research, conduct laboratory analyses, and present results at a campus-wide research symposium and write research papers. Because many of the students in the class work in our research labs, we encourage them to develop projects that build on these skills and techniques. The class provides a wide range of mentoring experiences, including both peer-to-peer and graduate student-to-peer mentoring. Each year we also conduct a Mentoring Undergraduates in Research seminar for graduate students.

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EXCHANGES OF AGGREGATE AIR NITROGEN EMISSIONS AND WATERSHED NITROGEN LOADS

The Chesapeake Bay TMDL sets limits on the load that can be delivered from tributaries and the air to the Bay. TMDL implementation measures take into account nitrogen deposition reductions from current national air rules (such as CAIR). For efficient management we want to take advantage of air emissions reductions that would occur in addition to national air rules to allow air-water trading. An approach has been developed to define transfer coefficients that can be used to convert changes in air emissions to changes in air deposition and subsequently to changes in loads delivered to the Bay. This approach uses a special CMAQ version that quantitatively attributes watershed and Bay deposition to individual Bay state emissions. The approach will be described. Source attribution maps and tables will be presented for air emissions of nitrogen oxides (NOx) to show the development of the overall attribution matrix and state transfer coefficients. Then an illustration will be presented showing the load reduction to the Chesapeake watershed (and subsequently to the Bay) and reduction directly to the Bay that would be estimated to accrue from a potential reduction in NOx emissions in the six Bay states that goes beyond current national regulations.

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EFFECTIVE SCIENCE COMMUNICATION STRATEGIES TO ADDRESS CLIMATE CHANGE, ENVIRONMENTAL MANAGEMENT AND RESOURCE ASSESSMENT

Various science communication strategies including printed materials (e.g., newsletters, booklets and books), electronic media (e.g., website, apps and social media), and in person events (e.g., presentations, meetings and workshops) have been used to communicate topical issues like climate change, environmental management and resource assessment. The Integration and Application Network at the University of Maryland Center for Environmental Science has developed several online science communication tools to enhance science communication effectiveness including: symbol libraries, image library, conceptual diagram creator, science communication examples and principles, an active blog conversation, various educational videos and education modules. A reflection on which of these approaches have been effective for the various different audiences provides guidance for science communication initiatives. There are several themes that have emerged from this reflection: 1) establishing environmental literacy principles about a topic or region is key, 2) sharing examples of good science communication techniques can stimulate emulation, 3) celebrating science communicator success stories helps personalize the process. The use of 'inverted' or 'flipped' classrooms for education and workshops is a technique gaining in popularity and some lessons about maximizing their effectiveness will be shared.

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NONMARINE SOURCES AND LOADING OF NITROGEN TO U.S. ESTUARIES

Previous assessments of land-based nitrogen loading and sources to U.S. estuaries have been limited to estimates for larger systems with watersheds at the scale of 8–digit HUCs and larger, in part due to the coarse resolution of available data, including estuarine watershed boundaries. We present a comprehensive assessment of nitrogen loading to estuaries and source partitioning linked to watersheds of 344 estuarine systems in the conterminous United States. Based on NHDPlus version 1 catchment data (http://www.horizon-systems.com/nhdplus/), watershed boundaries have been derived for 344 estuarine systems and are now publically available through the US EPA Estuary Data Mapper (EDM; http://ofmpub.epa.gov/rsig/rsigserver?edm/index.html). Loading and source estimates were derived from regional SPARROW models, supplemented by estimates of direct atmospheric deposition from the Community Multi-Scale Air Quality Model (CMAQ, http://www.cmaq-model.org/). The EDM application provides a user–friendly interface to CMAQ time series of loading data by estuary and estuarine watershed. USGS SPARROW model outputs are compared with more recent national data on the inputs of nitrogen by sources compiled by Sobota et al. (2013) at the HUC8 scale and updated to the HUC12 scale in 2013. This work will allow us to compare information on estuarine conditions with the magnitudes and sources of nitrogen inputs from upstream watersheds.

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RELATIONSHIPS BETWEEN CONCENTRATIONS OF PHYTOPLANKTON CHLOROPHYLL *A* AND TOTAL NITROGEN IN TEN U.S. ESTUARIES

This presentation focuses on the summertime response of phytoplankton chlorophyll to nitrogen concentrations in the upper water columns of ten U.S. estuaries. Using publicly available data from monitoring programs, regression relationships have been developed between summer surface concentrations of phytoplankton chlorophyll *a* and total (inorganic + organic) nitrogen (TN) for four estuarine embayments and six riverine estuaries on the U.S. Atlantic and Gulf of Mexico coasts. All systems show spatial gradients in chlorophyll *a* and nitrogen concentrations, and regressions over all stations within each estuary reveal substantial year-to-year variability in relationships between summer chlorophyll *a* and TN. Averaging data by station over several summers gives a measure of the mean response of chlorophyll *a* to TN for individual estuaries over an extended period, and facilitates comparisons among estuaries. Relationships found in this study fall into two classes. Relationships between chlorophyll *a* and TN for the four estuarine embayments are similar, with differences explained by concentrations of total suspended solids (TSS), used as a proxy for water clarity. Relationships between chlorophyll *a* and TN concentrations for the six riverine estuaries are weaker and more system-specific than for estuarine embayments. Unlike the estuarine embayments, these riverine systems exhibit substantial spatial gradients in TSS. When chlorophyll *a* – TN relationships are derived for spatial zones having relatively constant TSS, these relationships strengthen, with differences among most riverine estuaries explained by water clarity, as is the case for estuarine embayments. Included will be discussion of: 1) year-to-year variability in chlorophyll *a* – TN relationships, 2) similarities in long-term chlorophyll *a* – TN relationships among estuaries, and 3) implications of these results for classification of estuaries.

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LARGE SCALE WATER QUALITY IMPACTS ON SEAGRASS COMMUNITIES IN THE GREAT BARRIER REEF

Increasing severity, frequency and spatial extent (breaking connectivity) of water quality impacts has reduced resilience and challenge recovery processes of GBR seagrass meadows This work examines the correlation between water quality measurements over consecutive wet seasons and the corresponding changes in seagrass meadows in the central Great Barrier Reef. Utilising both remote sensing ocean colour information plus in-situ water quality has provided data over the appropriate spatial and temporal scales to allow the long term comparison of water quality and biological measurements. This analysis has demonstrated that exposure to primary water (characterised by high suspended sediment and moderate chlorophyll), can predict seagrass abundance as well as seagrass responses to event-based conditions. Seagrass areas exposed to high frequency of primary turbid waters through six consecutive wet seasons were characterised by low cover and low biomass, with consistently low measures of seagrass health. Seagrass areas with little or no exposure to primary turbid waters tend to be relatively intact with high biomass and little annual change. The seagrass areas which are exposed to both primary (Fp = 0.4 – 0.6) and secondary (characterised by high chlorophyll (Fs > 0.5) are the most at-risk, with high measures of annual biomass prior to 2007 declining and measuring the greatest annual relative change. Intermittent exposure to reduced water quality can result in relatively high biomass meadows but slight change in water quality can shift the balance in these seagrass communities. Large scale water quality mapping can help define the type of seagrass communities and identify the main water types which shape and drive seagrass response.

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COMPARISON OF HABITAT-SPECIFIC NUTRIENT REMOVAL AND RELEASE IN PACIFIC NW SALT MARSHES AT MULTIPLE SPATIAL SCALES

Wetlands can be sources, sinks and transformers of nutrients, although it is their role in nutrient removal that is valued as a water purification ecosystem service. In order to quantify that service for any wetland, it is important to understand the drivers of nutrient removal within the system of interest and its variability among systems of the same type. We compared short-term exchanges of inorganic N and P between surface water and salt marsh habitats (high marsh, low marsh, and tidal channel) at three spatial scales, including: within-marsh, within-estuary, and among-estuary. The study was conducted in summer 2012 at 20 salt marshes distributed among 8 Oregon estuaries. Nutrient fluxes were estimated using open-topped chambers deployed at low tide into which nutrient-amended artificial seawater was added. Patterns of nutrient exchange among habitats were consistent across all spatial scales for nitrite+nitrate (N+N) and phosphate (PO4), though there was substantial variability among marshes. In general, channel habitat had the greatest uptake of N+N and PO4, high marsh had the greatest efflux of both nutrients, while low marsh took up N+N and released PO4 but at lower rates. Nutrient efflux in high marsh habitat was correlated with abundance of Grindelia integrifola, a native forb. We suspect this may be due to salt excretion by these plants. Our next challenge is to compare the magnitude and direction of these fluxes relative to below-ground nutrient transformation and fluxes. Ultimately we will integrate these habitat-specific fluxes, marsh habitat area, and duration of inundation for each habitat type to estimate net short-term nutrient retention or release for PNW salt marshes of any habitat configuration and extent.

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FRESHWATER INFLOW IMPACTS ON SEAGRASSES IN A SUBTROPICAL LAGOON

The Lower Laguna Madre of Texas (LLM) is unique as a highly productive, hypersaline lagoon dominated by seagrass beds and characterized by historically low freshwater inflow (FWI) regimes. This situation of low FWI contrasts with most other estuaries where moderate to large amounts of FWI are considered essential to maintaining estuarine productivity. The conditions associated with high seagrass production and species expansions in LLM since the 1950s have been documented by Quammen and Onuf (1993) and Onuf (2006), based on analysis of mapping data and transect surveys between the 1950s and 2000. However, since 2000, the system has seen increasing loss of seagrasses, especially Syringodium and Thalassia in the northern region mostly in the vicinity of a eutrophic waterway, and Halodule in southern, deeper areas. We propose that these seagrass dynamics, along with nuisance/harmful algae blooms, high epiphyte loads, and high inflow pulses into the system, are indicators of high non-point source (viz. ungauged FWI) inputs with attendant high nutrient loading. In order to evaluate this hypothesis, we performed the following analyses and present results to: 1) Quantify the seagrass acreage losses in LLM over the period 1999–2010 based on aerial photography analysis and identify the species distribution changes based on field transect surveys; and 2) Correlate the spatial changes in seagrass coverage and species distribution with hydrology (gauged and ungauged inflows) and salinity regimes using GIS techniques, thus providing presumptive evidence for FWI zones of elevated-nutrient and reduced-salinity impacts on sensitive seagrass species.

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ASSESSING BIRD ABUNDANCE AND ASSEMBLAGE STRUCTURE IN TIDAL WETLANDS: IMPLICATIONS FOR RESTORATION SUCCESS

Bird communities are a critical component of tidal wetlands and constitute an important measure of the success of coastal wetland restoration. We present a statistical design to examine how bird assemblages might vary among both natural and restored tidal wetlands. Our study focused on a newly constructed wetland, San Dieguito Lagoon (SDL), and compared it to three natural reference wetlands spanning the Southern California Bight. Bird count data was taken from all four wetlands during winter and spring of 2011, 2012 & 2013 using sample survey data. Shortly after its construction, total bird density and species richness at SDL was within the range observed at the reference wetlands. In contrast to these univariate measures, multivariate analyses indicated much greater differences in assemblage structure between SDL and the reference wetlands than among the reference wetlands. Further multivariate analyses were done by partitioning assemblages into guilds (e.g. waterfowl, shorebirds) revealed that the abundance of both waterfowl and upland bird species in SDL contributed to the differences in assemblages between the restored and natural wetlands. We speculate that habitat differences between SDL and the reference wetlands as well as differences in surrounding habitat mix are likely driving the differences we observed.

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WHEN GOURMET IS NOT ENOUGH: ORGANIC MATTER SOURCES SUPPORTING THE HIGH PRODUCTION OF *CORBICULA FLUMINEA* IN AN INVADED ESTUARY

The Asian clam Corbicula fluminea is one of the most pervasive species in freshwater ecosystems. Our objective was to characterize the food sources fuelling C. fluminea in the Minho river estuary (NW-Iberian Peninsula, Europe), an estuarine ecosystem in which C. fluminea dominates the benthic macrofauna biomass. Thus, we identified and quantified the contribution of different organic matter (OM) sources to C. fluminea's biomass along the estuarine mixing zone, using C and N stable isotope analysis. A pronounced shift in the quality of OM available for C. fluminea occurred along the salinity gradient. Particulate OM was largely comprised of terrestrial derived OM in freshwater stations and was increasingly comprised of phytoplankton, a more palatable food source, towards the polyhaline estuary. A similar shift in isotopic composition along the estuarine mixing zone was observed in C. fluminea, suggesting a shift in the food sources used in response to the change in food quality. Although the majority of the food sources identified during this study were being filtered from the water column (70-90%), reliance on sediment OM and microphytobenthos provided evidence for deposit feeding by C. fluminea. Thus, we suggest that C. fluminea has the ability to adapt to environments with low food quality, which can be a competitive adaptation in systems with perennial low food quality, such as the Minho River estuary. Moreover, its ability to link terrestrial and estuarine ecosystems, constitutes a new identified process by which C. fluminea may alter food web flows in aquatic ecosystems. As an invader, the implication of this adaptive and flexible feeding behavior is that it likely facilitates its widespread success at establishing in new aquatic environments.

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ARE *SPARTINA ALTERNIFLORA* PLANTS FROM DIFFERENT MARSHES EQUALLY PRODUCTIVE AT SIMILAR ELEVATIONS?

The aboveground growth response of Spartina alterniflora in "marsh organs" was compared for plants from a marsh with sandy, low organic matter (6-8%) soil to those from a marsh with silty, higher organic matter (> 20%) soil in a reciprocal transplant experiment. Elevations of the marsh organ rows (6 rows) ranged from ca. 0 to 60 cm above MSL. In each row of six columns, three pipes were planted with S. alterniflora from each marsh. Duplicate organs were located adjacent to the two source marshes. Plants were harvested at the end of the growing season, and analyzed for stem number, height, and biomass. Preliminary results show that biomass was positively correlated with increasing elevation for plants from both sources, but that the relationship was strongest for the plants originating in the marsh with organic rich soil. Further, the biomass of plants grown in organs was less than the biomass of plants growing in the source marshes at similar elevations. This result suggests that marsh organ studies using only a single plant source may not reflect the breadth of plant responses possible in marshes and that elevation, or variables influenced by elevation, are insufficient to explain S. alterniflora biomass production in marshes.

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WATER QUALITY IN OUR GREAT LAKES NATIONAL PARKS: WHAT WE HAVE LEARNED IN PARTNERSHIP WITH THE US EPA

Water quality issues do not begin or end at the boundaries of our national parks. The 2012 Revisiting Leopold report challenges us to practice large-scale stewardship and understand connectivity across seascapes. In Partnership with the US Environmental Protection Agency's (US EPA), National Coastal Condition Assessment (NCCA) methods were applied in Great Lakes national parks to advance regional-scale water quality monitoring. The NCCA probabilistic survey design was used to assess the quality of park waters and to identify water quality issues that may impact park resources, but originate beyond park boundaries. In 2010, samples were collected at five National Park sites in Lake Superior and Lake Michigan coincident with NCCA samples for water chemistry, sediment chemistry and toxicity, and benthic macroinvertebrate communities. Spatial analysis of water chemistry data shows relatively homogenous coastal waters in Lake Superior, with the exception of those in the Duluth Harbor and in the vicinity of Isle Royale National Park. Likewise, the coastal waters of Lake Michigan national parks are generally similar to the greater lake, with the exception of Green Bay. Effects of environmental stressors on sediment macroinvertebrate communities were explored using benthic indices and risk assessment approaches. Potential implications for park management and future monitoring are discussed in the context of the survey results.

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METAGENOMIC ANALYSIS OF THE *PHACOIDES PECTINATUS* ENDOSYMBIONT CONSORTIUM REVEALS METABOLIC VERSATILITY AND POTENTIAL ADAPTATION TO ANTHROPOGENIC DISTURBANCES

Endosymbiotic associations between metazoans and microorganisms in marine environments are responsible for active biogeochemical cycling of sulfur, carbon, and nitrogen compounds. The Lucinidae are the most taxonomically diverse clade of chemosymbiotic marine bivalves and have previously been shown to harbor sulfur-oxidizing bacteria in their gills. Because many lucinid species live in shallow sediments from mangroves and seagrass beds, the health of coastal ecosystems is dependent upon this symbiotic association, although much still remains to be learned about the associations and vulnerability to anthropogenic disturbances. Our recent metagenomic investigations of lucinid Phacoides pectinatus gill tissue from hosts near Ft. Pierce, Florida, reveal Gammaproteobacteria dominate the host-associated endosymbiont metagenomes, with >60% of all annotated sequences being affiliated with this class. However, genes affiliated with other proteobacterial groups suggest greater taxonomic and physiological diversity than earlier studies indicate.The endosymbiont consortium has nearly complete pathways for sulfur oxidation (via rDsr and Apr), and high abundances of FccAB and sulfate adenylyltransferase homologs. Carbon fixation is based on partial Calvin-Benson and rTCA cycle pathways, and key genes for the RuMP and serine pathway are also present. These pathways provide evidence for C1 metabolism, which has not been previously demonstrated for lucinids. High abundances of genes for denitrification (Nap, Nir, Nor) are present, as well as genes for enzymes known in the catabolic degradation of xenobiotics, including aromatic compounds. These results may indicate that members of the endosymbiont consortium are capable of withstanding some level of xenobiotic impact. The endosymbiont metagenomes also extend our current knowledge of lucinid chemosymbiosis from shallow marine environments and provided important information about sediment biogeochemical cycling.

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FACILITATION OF NATIVE AND NON-NATIVE SPECIES BY INTERMEDIATE FOUNDATION SPECIES

Facilitation cascades stem from co-occurring habitat-forming species that add biogenic structure to otherwise barren ecosystems. Specifically, they are formed when the primary (basal) foundation species enables the establishment of intermediate (secondary) foundation species. Recent studies have found them to positively influence biodiversity and abundance of species and these effects can be species-specific. While studies have been carried-out on the ecological significance of foundation species, explicit investigation into the effects of intermediate foundation species on the distribution of associated native and non-native species is rare. Here, we used field and laboratory studies to investigate the effects of intermediate algal foundation species (Ascophyllum nodosum and Fucus vesiculosis) on the abundance and distribution of dominant intertidal herbivores, Littorina saxatilis (native) and L. littorea (non-native) in US East Coast cordgrass systems. Our results suggest that the presence of intermediate foundation species facilitates survival of the native species, L. saxatilis. Furthermore, the two intermediate algal foundation species acted in diverse ways to enhance the abundance of the native and the non-native herbivore. F. vesiculosis was important for the early life-history stage (i.e., recruitment) of L. saxatilis while both algal intermediate foundation species were central to the gastropods persistence. In contrast, both algal species were critical for the early life-history stage (i.e., recruitment) of L. littorea while A. nodosum was important for its persistence. These findings reveal that intermediate foundation species can act as regulators of native and non-native species abundance and distribution.

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ELUCIDATING FOOD WEB DYNAMICS OF ARTIFICIAL OYSTER REEFS IN MISSISSIPPI SOUND

A total of 605 individual organisms were analyzed for stable carbon and nitrogen isotopes from two sites in the Mississippi Sound Estuary where oyster shells were deployed for 6 weeks. Toadfish were the largest organisms typically found and were also the top resident predators. Gobies were the most numerous top predators found at all sites. Sleeper fish were found at both sites and had wide variability in their isotope values, suggesting they were either more transient or tended to forage further away from the sites relative to other fish. Grass shrimp were abundant at all sites and were slightly below gobies in their trophic position. Polycheates were also common at all sites and their 15N values were similar to grass shrimp indicating that they occupy a similar trophic level. Xanthid crabs represented the lowest trophic position at each site and were one of the major taxa at each site. Blue crabs and amphipods were not as common but were similar to mud crabs in their stable isotope values. Carbon isotope values were the most deplete for organisms from the lowest trophic levels indicating terrestrial detritus is an important carbon source for lower trophic levels. As one grades into higher trophic levels 13C values become heavier which could be due to increasing reliance on benthic microalgae or marine phytoplankton carbon sources. Alternatively, the organisms collected at these sites could be heavier in 13C due to trophic isotopic fractionation of carbon. Carbon isotope data suggest inshore sites were more dependent on marsh and/or terrestrial detritus than sites in Mississippi Sound, where isotopically heavier carbon sources such as benthic macroalgae or marine phytoplankton contributed more carbon to reef consumers. Results will be compared to isotopic values of oysters and other consumers collected from natural and constructed oyster reefs from the nearby Grand Bay NERR.

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MICROZOOPLANKTON GRAZING EXPERIMENTS USING THE DILUTION TECHNIQUE YIELD REPEATED POSITIVE SLOPES IN A PRODUCTIVE, SUBTROPICAL LAGOON

Microzooplankton grazers are thought to consume the majority of pelagic primary production in marine environments, including estuaries, and their grazing activities have implications for ecosystem energy flow, nutrient cycling, primary producer community structure, and harmful algal bloom development. The most widely accepted method for measuring microzooplankton grazing rates, the dilution technique, was developed in oligotrophic, open-ocean environments. Applications of the technique in productive waters have resulted in varied responses that often complicate the interpretation of results in light of potential violations of assumptions. Grazing experiments using the dilution technique were carried out for 12 months at two sites in the Indian River Lagoon, Florida, an underrepresented ecosystem type with regards to global knowledge of microzooplankton grazing. Positive grazing rates were observed in the majority of experiments implying that grazing activity actually enhanced phytoplankton growth even when nutrients were not limiting. In two such experiments, plankton identification data supported the hypothesis that grazer net growth rates were not constant over the incubation period and were related to dilution level, i.e., an important assumption was violated. Also, differences in temporal patterns of phytoplankton biomass and growth rates among the two sites in relation to temperature and nutrient dynamics point to differences in the structure and function of their respective food webs. The frequency of positive grazing rates observed in this study and the fact they were potentially driven by different processes at sites only 8 km apart highlight the need for more detailed studies of trophic interactions within estuarine plankton communities.

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EFFECTS OF WIND MIXING ON NUTRIENT DYNAMICS AND AMMONIUM PROCESSES IN A SHALLOW COASTAL POND

In order to reduce eutrophication effects, coastal managers aim to decrease anthropogenic nutrient input to coastal waters. Understanding the nutrient cycle in coastal environments provides insight on the fate of external nutrient inputs. To study nutrient dynamics we examined the effects of wind mixing in a shallow, freshwater, coastal pond fed by a wastewater treatment plant (WWTP). A unique in situ sediment core incubation system ("corecosm") isolated intact sediment cores and overlying water in enclosed chambers, and removed wind and lateral nutrient exchange effects. We installed corecosms for 6 days and took surface and bottom water samples every other day from inside and outside the corecosms. We measured oxygen, nitrate, nitrite, ammonium and phosphate concentrations from water samples. To examine ammonium uptake and regeneration by bacteria and phytoplankton, we added 15N-ammonium and incubated water samples with and without light exposure., Despite isolation from wind mixing, there were no differences in concentrations or rates between surface and bottom water samples, suggesting the water in the corecosms was well mixed by internal processes. Oxygen levels remained saturated, and high levels of nitrate supplied by the WWTP decreased steadily over time inside the corecosms. Ammonium and phosphate concentrations were higher in the corecosms than in ambient waters. Ammonium uptake was greater than regeneration in the water column and greater in the light than in the dark incubations. These results suggest ammonium was supplied from sediment regeneration, and phytoplankton uptake dominated over bacterial regeneration in the water column. The corecosm is a useful tool to distinguish between external and internal sources of nutrients and measure nutrient rates in the absence of wind mixing in shallow coastal ecosystems.

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PREDATOR EFFECTS ON OYSTER FILTRATION

Oysters have been recognized for a number of valuable ecosystem services, all of which rely at some level on their capacity as filter feeders. Interest in top-down control of bivalves, through both direct and indirect effects, has increased in recent years, including efforts to link top-down effects to filtration. This study sought to separate the factors to evaluate oyster's perceived sense of risk and the effect it may have on ecosystem services by evaluating the effects scent cues, physical disturbance, and predation have on chlorophyll a concentrations in mesocosms. Preliminary trials showed no effect of "fear" in response to predator presence in larger size class oysters. However, potential effects may occur in smaller oysters or with the addition of further predation risk cues, e.g. physical contact. Additional experiments are underway using a broader range of oyster sizes (5mm-adult) a broader range of predation stimuli. We hypothesize that oysters may face a horizon of risk where fear of predators and the need to reach a critical size refuge modulate filtration activities.

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EFFECT OF SEASON AND SCALE ON POWER TO DETECT CHANGE IN MANGROVE FISH ASSEMBLAGES OF A CONVERTED ESTUARY

An expansion is underway of a nuclear power plant on the shoreline of Biscayne Bay, Florida, USA; the effects of its construction and operation on surrounding marine and estuarine habitats and fishes are unknown. The power plant, surrounded by protected historic wetlands less than 25 miles from Everglades National Park, borders Biscayne National Park, part of a formerly-estuarine freshwater pulsed lagoon that is undergoing restoration as part of the Comprehensive Everglades Restoration Plan. The present study examined data gathered as part of an ongoing monitoring survey of fish communities associated with mangrove habitats directly adjacent to the power plant. Our objective was to determine the adequacy of the survey to detect fish community changes, should they occur, at three spatial scales. Using seasonally-resolved data recorded during 477 fish surveys over 5-year period, power analyses were performed for three metrics (fish diversity, fish density and the occurrence of two ecologically-important fish species (Lutjanus griseus and Floridichthys carpio). Results indicated that the monitoring study at current sampling intensity allows for detection of a < 30% change in fish density and diversity metrics in both the wet and the dry season. However, sampling effort is insufficient in either season to detect a < 30% change in species-specific occurrence metrics for the two important fish species examined. More effective monitoring strategies could be achieved by increasing sampling intensity within each season until effort allocation is sufficient to detect 30% change for each metric after only one year of post-impact sampling. Responsible monitoring practices are increasingly important in light of cumulative impacts to estuaries in South Florida resulting from hydrological alteration, coastal development and water quality degradation among others.

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THREE NON-NATIVE JELLYFISH IN THE SAN FRANCISCO ESTUARY: DISTRIBUTION, ABUNDANCE, AND POTENTIAL IMPACTS

Three species of jellyfish indigenous to the Black Sea (Blackfordia virginica, Maeotias marginata, and Moerisia lyonsi) have become established in low-salinity habitats of the San Francisco Estuary (SFE). All three jellyfish spatially and temporally overlap with protected planktivorous fish, and share a similar diet consisting primarily of copepods. This study quantifies the distribution and abundance of all three species within four brackish-water tributaries of the SFE from early summer to late fall during 2010 and 2011. Jellyfish and their prey were sampled weekly or biweekly and environmental variables were recorded. The upper quartile abundance for B. virginica was 95 medusae m-3 in 2010 and 115 medusae m-3 in 2011, exceeding previous reports of <5 medusae m-3. The upper quartile abundance of M. marginata (2 medusae m-3 in 2010 and 2011) and M. lyonsi (13 medusae m-3 in 2010 and 50 medusae m-3 in 2011) are similar to previous reports. Information on abundance was combined with feeding rates measured in the laboratory (B. virginica and M. marginata) or taken from the literature (M. lyonsi) to estimate predation impacts. The highest potential impact was 20 – 60% of the water column cleared per day estimated for B. virginica, which is higher than the population growth rates of their copepod prey. Hydromedusa populations in the SFE have the potential to locally depress copepod populations, potentially reducing the prey available for protected species of fish.

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CLIMATE-INDUCED EXPANSION OF THE FLORIDA MANGROVE-MARSH ECOTONE: IMPLICATIONS FOR WETLAND CARBON STORAGE

The coastal wetlands of the southeastern US represent a dynamic plant community that is susceptible to the effects of climate change. Historical aerial imagery paired with meteorological data suggest that a warming climate has facilitated the northward expansion of the marsh-mangrove ecotone, the transitional area between adjacent ecosystems. Previous studies indicate significantly higher levels of carbon storage in mangrove habitat than salt marsh, which correlates to increased mangrove root volume, soil strength and resistance to sea level rise and storm events. We aimed to examine the potential impacts to large-scale carbon storage that accompany mangrove range expansion. We used the marsh-mangrove ecotone community present at the Merritt Island National Wildlife Reserve (MINWR), FL, USA (28°40'N, 80°46'W) to assess carbon storage for mangrove species (*Rhizophora mangle*, *Avicennia germinans*, and *Laguncularia racemosa*), salt marsh species (*Salicornia bigelovii*, *Batis maritima*, *Spartina alterniflora* and *Distichlis spicata*), and transitional areas containing mangrove seedlings and juveniles. Our carbon storage analysis was partitioned into above- and below-ground living biomass and soil carbon, which was assessed through selective harvesting, allometry and soil coring. Results indicate varying levels of significance in carbon storage between species within each wetland type, but there is evidence for increasing carbon storage between salt marsh habitat, transitional areas and mangrove habitat. These data represent the first step in monitoring and modeling the impacts of a warming climate on coastal wetland plant communities and subsequently, large-scale wetland carbon storage. Future directions include pairing our plot-level carbon estimates with remote sensing data and climate envelope modeling to extrapolate these data to a sub-regional scale for the current landscape at MINWR, as well as a future landscape influenced by increasing temperatures.

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CONTINUOUS MONITORING OF DISSOLVED OXYGEN IN SAN FRANCISCO BAY, CALIFORNIA

Since passage of the 1972 Federal Clean Water Act, reported dissolved oxygen (DO) concentrations in San Francisco Bay (Bay) are routinely above the 5 mg/L standard important for supporting biota, with few reported episodes falling below this concentration. However, long-term monitoring efforts have measured DO only in the main channel of the estuary by research vessel, and only at weekly to monthly sampling intervals. For this study we conducted the first high temporal resolution deployment of dissolved oxygen sensors in

both the main channel and the perimeter of the Bay. Four optical DO sensors were deployed near bottom and sampled every 15 minutes for a year: two in the main channel (depth > 12 m) and two in the estuary perimeter (depth < 5 m). Main channel sites included one in the upper estuary near the primary freshwater inflow and one in the lower estuary near the ocean boundary; estuary perimeter sites included one at the mouth of a tidal creek in Central Bay and one in a tidal slough in South Bay. The resulting time series for sites in the main channel showed DO concentrations which always exceeded 5 mg/L, whereas during spring, summer, and fall the tidal slough exhibited sustained hypoxic conditions (< 3 mg/L) and the tidal creek daily minima dropped below 5 mg/L. Compared to sites in the main channel, those along the estuary perimeter demonstrated greater variability in DO concentrations at seasonal, tidal, and especially diurnal time scales. At the tidal slough site, DO concentrations varied at the spring/neap time scale, with consistently lower concentrations during neap tides indicating tidally varying transport and system metabolism. These time series are the first to concurrently document the contrasting DO patterns in the main channel versus the shallow periphery of the Bay, with results highlighting the value of high temporal resolution sampling and the importance of measurements in the shallow habitats.

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RESPONSE AND RECOVERY OF MICROBIAL COMMUNITIES IN LOUISIANA COASTAL MARSHES AFTER THE DEEPWATER HORIZON SPILL AND THE POSSIBLE IMPLICATIONS FOR MARSH EROSION

Louisiana marshes are important edge ecosystems critical to coastal sediment retention, accumulation, and accretion. Much of the research on marsh soil stability has focused on plant communities and their rooting depths or on benthic microalgal and diatom communities that colonize surface sediments. But, the majority of marsh organic soil material is created within the marshes by microbial degradation of plant material and changes in degradation rate could drastically alter soil stability. Additionally, microbial extracellular polymeric substances secreted into sediment increase particle cohesion. However, little is known about marsh sediment microbial functional diversity, and the impact changes to water depth, plant community structure, or the introduction of stressors, have on marsh microbial community structure and composition. Do changes to microbial taxonomic and functional levels result in soil stability changes? The 2010 Deepwater Horizon oil spill was a unique chance to evaluate marsh sediment microbial communities before and after the event and to assess how changes at the microbial level could impact soil stability at the ecosystem level. Microbial diversity at marsh edges was evaluated from 16S rRNA gene pyrosequences corresponding to marsh vegetation, hydrocarbon concentration, and soil strength measurements taken at the edge and on the marshes. Our results indicate that communities shifted from Proteobacteria- to Firmicutes-dominated. By 2013, it appears that microbial communities have not recovered to pre-spill compositions, and marshes have increased water depths and changes to vegetative cover and soil strength. These changes favor anaerobic metabolism like fermentation. Continued microbial diversity evaluations, combined with organic carbon content, extractable carbohydrate concentrations, bulk density and particle size analysis assessments from the sediments correlate to decreases in marsh soil stability to microbial community changes.

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CHESAPEAKE BAY SHORELINE EROSION CONTROL EXPERT PANEL: CHARGE, PROCESS, AND PRODUCTS

The Chesapeake Bay is the largest estuary in North America that spans six northeastern US states and the District of Columbia. The Chesapeake Bay is a vital ecosystem resource that is impacted from decades of pollution, overfishing and other human activities. In 2012, the Environmental Protection Agency (EPA) developed a Total Maximum Daily Load (TMDL) for the Chesapeake Bay that sets pollution limits necessary to meet water quality standards by 2025. One of the challenges facing EPA was the ability to identify the suite of practices needed to meet the target and a standardized process of crediting and tracking progress of implementation. State and local governments use a variety of BMPs, land use changes, and other strategies to plan, implement, and chart progress to meet local as well as the Bay TMDL goals. The EPA Chesapeake Bay Program - a partnership of federal, state and local organizations in the watershed – developed a "expert panel" process to provide a uniform method of crediting best management practices (BMPs). The purpose of the expert panel is to recommend pollutant removal efficiencies for new BMPs or update existing BMPs. The expert panels use a consistent, transparent, and scientifically defensible protocol to develop, review, and approve loading and effectiveness estimates for nutrient and sediment controls. This talk focuses on the Shoreline Erosion Control (SEC) panel and will discuss the following: 1) the need to update the SEC nutrient and sediment load reduction; 2) the panel charge and process; 3) and panel findings, to date. The expert panel members meet regularly to review the literature, develop protocols/methods, and ultimately provide recommendations to EPA CBPO for estimating the benefits of restoring the Bay's 4,600 shoreline miles.

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A LONG-TERM COMPARISON OF CARBON SEQUESTRATION RATES IN IMPOUNDED AND NATURALLY TIDAL FRESHWATER MARSHES ALONG THE LOWER WACCAMAW RIVER, SOUTH CAROLINA, USA

Carbon storage was compared between impounded and naturally tidal freshwater marshes along the Lower Waccamaw River in South Carolina. Soil cores were collected in two naturally tidal and two moist soil (impounded, seasonally drained since ~1970) "treatments". Cores were sectioned and analyzed for % organic carbon, % total carbon, bulk density, and ^{210}Pb and ^{137}Cs for dating purposes. In addition, due to a strong manure odor from the naturally tidal cores, 3 core sections from one core (0-3 cm, 9-12 cm and 30-33 cm) were analyzed using microbial source tracking for the presence of the fecal indicator Bacteroides-Prevotella in order to determine the provenance of the purported manure. When compared over a period of 40 years, the naturally tidal treatment had a significantly higher carbon sequestration rate (mean = 219 g C m^{-2} yr^{-1} vs. mean = 91 g C m^{-2} yr^{-1}) and four times the vertical accretion rate (mean = 0.84 cm yr^{-1} vs. mean = 0.21 cm yr^{-1}) of the moist soil treatment. Inorganic sedimentation was significantly lower in the naturally tidal treatment (251 g m^{-2} yr^{-1}) than the moist soil treatment (479 g $m^{-2}yr^{-1}$). The microbial source tracking analysis confirmed the presence of bovine and/or ruminant manure at each of the depth ranges measured, indicating that the marsh may be serving as a sink for fecal bacteria populations, as well as carbon. The overall results of the study suggest that the long drainage period in moist soil management limits carbon storage over time. Managers across the National Wildlife Refuge system have an opportunity to increase carbon storage by minimizing drainage in impoundments as much as practicable. Further research in a broader range of sites with a full carbon inventory and tests of carbon provenance is required to better understand the carbon dynamics in these sites and the constituents of the soil carbon pool.

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EFFECTS OF NUTRIENT RATIOS OF WOODY AND HERBACEOUS TAXA ON ECOSYSTEM PRODUCTIVITY ALONG A LATITUDINAL GRADIENT

Plant biomass and nutrient allocation are directly linked to the productivity of specific ecosystems. Nitrogen (N) to phosphorus (P) ratios are of particular concern when describing ecosystem productivity since they play such an important role in plant growth and ecosystem functioning. From growing new leaves to transfer of energy, N and P are critical to growth and survival; yet availability of these nutrients is often a limiting factor. N: P ratios of mangrove and saltmarsh species coexisting in the same soil were studied along a latitudinal gradient ranging from Bocas del Toro, Panama in the south to St. Augustine, Florida in the north. To analyze differences in nutrient allocation of mangrove and salt marsh species we harvested a woody plant (mangrove) and an herbaceous plant (marsh) rooted in the same soil in replicates of 5 per site. Each plant was then divided into four critical parts; roots, stems, leaves, and reproductive parts, coming up with a separate nutrient ratio for each organ. Results of this study will be helpful in making predictions concerning the fate of the two ecosystems as mangroves slowly make their way north, encroaching into the pure salt marsh as a result of global warming and sea level rise.

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THE USE OF A MODIS BAND-RATIO ALGORITHM VERSUS A NEW HYBRID APPROACH FOR ESTIMATING COLORED DISSOLVED ORGANIC MATTER (CDOM)

Satellite remote sensing offers synoptic and frequent monitoring of optical water quality parameters, such as chlorophyll-*a*, turbidity, and colored dissolved organic matter (CDOM). While traditional satellite algorithms were developed for the open ocean, these algorithms often do not transfer to more optically-complex coastal and estuarine waters. Previously, an empirical Moderate-Resolution Imaging Spectroradiometer (MODIS) band-ratio algorithm was found suitable (R^2=0.77; p-value<0.0001; RMSE=0.79) for measuring CDOM absorption at 412 nm in northwest Florida estuaries. However, potential atmospheric correction errors cause uncertainty in satellite-derived remote sensing reflectance [$R_{rs}(\lambda)_{0+}$] and thus, uncertainty in the estimates derived from band-ratio algorithms. A new hybrid approach (R^2=0.70; p-value<0.0001; RMSE=0.46) combined the use of empirical and semi-analytical algorithms to derive measures of CDOM absorption at 443 nm, and is expected to yield more accurate estimates of optical water quality parameters in estuarine waters than

the use of band-ratio algorithms alone. This study investigated the performance of both approaches and considers options for optimal algorithm performance.

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SANDY BEACHES AS RECIPIENT ECOSYSTEMS: THE INFLUENCE OF SUBSIDIES ON INTERTIDAL COMMUNITY STRUCTURE AND HIGHER TROPHIC LEVELS

Sandy beach ecosystems depend on allochthonous subsidies, creating strong links to primary production of phytoplankton and marine macrophytes in adjacent marine ecosystems. These subsidies support abundant intertidal suspension-feeding and wrack-dependent invertebrates on beaches. Suspension-feeding invertebrates generally make up the bulk of intertidal biomass and abundance, while wrack-associated invertebrates are a major element of species richness. Intertidal species richness and species richness and abundance of wrack-associated invertebrates were highly correlated with macrophyte wrack in field surveys. Results from groomed beaches and field experiments that manipulated wrack supported these results. Suspension-feeders responded to beach slope, surf and swash dynamics that could affect production and delivery of phytoplankton. Higher trophic levels, specifically shorebirds, respond to prey subsidized by phytoplankton and macrophyte wrack differently. Shorebird species richness was correlated with invertebrate richness and the abundance of talitrid amphipods and wrack. Shorebird abundance was correlated with invertebrate biomass but response varied among shorebird types. Abundance of large-bodied shorebirds was strongly correlated with prey abundance and biomass, including suspension-feeding hippid crabs and wrack-consuming talitrid amphipods. However, calidrine shorebird abundance was not correlated with prey availability. The abundance of visually feeding plovers was correlated with the amount of wrack and the abundance of wrack-associated invertebrates. Nest density and the number of chicks hatched km^{-1} of beach of an endangered beach-nesting plover (Western Snowy Plover) were significantly related to wrack and wrack-associated prey abundance. Changes in the availability of macrophyte wrack and phytoplankton subsidies to beach ecosystems can strongly influence intertidal invertebrate food webs and profoundly alter prey availability to higher trophic levels.

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ANATOMY OF A SOUTH SAN FRANCISCO BAY SPRING BLOOM

Recent studies of phytoplankton bloom initiation in the northern San Francisco Estuary (SFE) reveal a predictable pattern: 1) algal ammonium (NH4) uptake causes a decline in NH4 concentration, enabling 2) a larger pool of DIN, nitrate (NO3) to be assimilated by phytoplankton that results in 3) rapid chlorophyll accumulation that outpaces dispersive losses leading to a phytoplankton bloom. The question arose as to whether spring blooms in South SFE (South Bay) follow the same sequence. South Bay is different from the northern SFE in at least two respects: 1) a lagoon type circulation pattern that results in longer residence time and 2) discharge of advanced secondary treated effluent with high NO3 concentrations. In 2008, the spring phytoplankton bloom in the South Bay followed the pattern observed for the northern SFE. Compared to high winter values in January, by mid-April, NH4 declined (from ~15 μmol L-1 to <1 μmol L-1), along with NO3 (from ~50 μmol L-1 to virtually zero) and chlorophyll increased (from 5 to > 40 μg L-1). A decline in silicate (Si(OH)4) from 85 μmol L-1 to virtually zero signified a very substantial production of diatoms. The 2008 bloom was analyzed further by contouring nutrient and chlorophyll concentrations on location and time axes. The space-time contours of Si(OH)4, NO3, NH4 and chlorophyll concentrations showed the progression of the bloom in South Bay from south to north with the decline in both Si(OH)4 and NO3 and the increase in chlorophyll tracking the contour where NH4 =1 μmol L-1 . Additionally, nitrogen uptake rates measured using 15N tracers showed the same inhibition of NO3 uptake by NH4 observed in the northern SFE. The keys to large spring blooms in South Bay are, in addition to favorable irradiance conditions, a high ratio of NO3:NH4 and long residence time allowing NH4 concentrations to be reduced to the low levels that enable rapid uptake and full utilization of the very large NO3 and Si(OH)4 pools by diatoms.

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SCIENCE AND MANAGEMENT: CLIMATE CHANGE INDICATORS FOR THE NORTH-CENTRAL CALIFORNIA COAST AND OCEAN

Resource managers and decision-makers in North-central California have identified a need for increased scientific information about the impacts of climate change on the region's coast and ocean to ensure that coastal management decisions are grounded in sound science. To help meet this need, ocean climate indicators were developed for the North-central California coast and ocean, from Point Año Nuevo to Point Arena, including the Pacific coastline of the San Francisco Bay Area. Based at NOAA's Gulf of the Farallones National Marine Sanctuary, this collaborative project brought together over 50 regional research scientists and resource managers representing federal and state agencies, research universities and institutions, and non-governmental organizations. Following the indicator development process, an interdisciplinary working group incorporated the indicators into a regional indicators monitoring inventory and plan that can be used by scientists, natural resource managers, and state and municipal planners to monitor, track, and develop adaptation strategies for the impacts of climate change on the region. The working group collaborated extensively to identify key measurements and data sources for the indicators, and to ensure that the monitoring plan was accessible and convenient for decision-makers while still providing a valuable technical resource for research scientists.

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SCIENCE AND POLICY OBJECTIVES FOR A NEW OCEAN OBSERVING PLATFORM ON THE SOUTH SHORE OF MONTEREY BAY

In the face of a changing climate, it is important to document the natural chemical and biological variability of healthy ecosystems to understand how they function and to be able to document shifts from these current baselines. The Center for Ocean Solutions has built a cabled observing platform just off shore of the Hopkins Marine Station in Monterey in order to easily facilitate high-resolution studies of a productive kelp forest system located within a marine protected area. This cabled platform allows for long term, high resolution data from an almost unlimited number of instruments. With a design life of over 10 years, this platform provides a long-term data set of important ocean measurements such as, temperature, salinity, velocity, pH, nitrate, and a live streaming camera. Subsets of the data are live streaming to the web allowing adaptive sampling as well as access to a wide range of users. Furthermore, due to the ease of adding instrumentation to the system, if needs of scientists or managers change, or if new monitoring technology becomes available, the system can easily be adapted to reflect these changes. Based on this prototype design, smaller, more cost effective platforms may be feasible and could be installed in a number of coastal systems. A network of these systems monitoring baseline variability in a number of differing coastal systems could prove invaluable in assessing climate change and anthropogenic stress effects. In addition to rich science possibilities, these long term data sets will help inform how and when water quality thresholds have been violated. For example, under the Clean Water Act pH is deemed a pollutant however, the Clean Water Act pH standard presumes a much narrower range of natural variability than the initial monitoring results reveal. With long term pH measurements, more realistic pH thresholds can be set.

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FIFTY YEARS OF IMPROVING WATER QUALITY IN LOWER SOUTH SAN FRANCISCO BAY

Prior to the construction of the San José/Santa Clara Regional Wastewater Facility (Facility) in 1957, untreated raw sewage flowed directly into Lower South San Francisco Bay (Lower South Bay). Originally constructed as a primary-only treatment plant, the Facility provided basic treatment of raw sewage generated by the cities of San José and Santa Clara. Population growth in Silicon Valley during the 60s and 70s led to decreased water quality in the Lower South Bay with ambient conditions regularly reaching anoxic levels. In response to population growth and new regulations, the Facility expanded its treatment capacity and

improved the level of treatment, adding nitrification and filtration in 1979, then converting to biological nutrient removal (BNR) in 1998. An analysis of five decades of changes in receiving water quality in the Lower South Bay in the context of Facility expansions and improvements helps answer the question: Did Facility expansion and improvements correspond to observed improvements in Lower South San Francisco Bay water quality? We examined fifty years of ambient receiving water data for dissolved oxygen, water clarity, nutrients, and pH for temporal correlations to key Wastewater Facility improvements. The 1979 upgrade corresponds to an immediate improvement in effluent BOD, TSS, and ammonia, with corresponding improvements in Lower South Bay dissolved oxygen and ammonia levels. The 1998 conversion to BNR lowered nitrate and phosphate loads to the Lower South Bay and a reduction in ambient nitrate and phosphate concentrations is evident. An analysis of long-term effluent and receiving water quality data demonstrates the benefits of wastewater treatment plant improvements that can be quite expensive. Resurrecting historic data helps demonstrate the value of public investment in a large wastewater facility, documents long term impacts on the local environment, and strengthens the link between wastewater treatment and local water quality.

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DYNAMICS OF LOW-SALINITY LAYERS AND INTERTIDAL COMMUNITIES IN RESPONSE TO FRESHWATER INPUTS IN NEW ZEALAND FIORDS

A buoyant low-salinity layer (LSL) resulting from high rainfall is a characterizing feature of all New Zealand fiords. However, the LSL in Doubtful Sound is more persistent than in other fiords due to the continuous input of freshwater from the Manapouri Power Station tailrace, which became operational in 1969. This persistent LSL has a clear effect on the intertidal and shallow subtidal communities. Changes to the intertidal communities since the operation of the power station have included seaward shifts in the horizontal distributions of species, and restriction of some species to the subtidal. Historical datasets and recent photographic mapping have indicated taxa once dominant in the inner Sound, such as barnacles and mussels, have shifted ~7 and 15 km seaward, respectively. We examined changes in intertidal communities across a variety of spatial and temporal scales, and found that while there were significant changes in distributions and abundances during the initial operation of the station, the composition and horizontal distribution of intertidal communities in Doubtful Sound have been consistent among separate surveys conducted over the past 28 years. They have remained similar over that time period despite large fluctuations in both annual tailrace discharge and rainfall (e.g. wet and dry years). Communities in inner Doubtful Sound (closer to the tailrace) are low in diversity and have remained the most similar due to the stabilizing effect of the tailrace discharge on the salinity regime. Conversely, communities found in outer Doubtful Sound and other fiords are exposed to a much more dynamic salinity regime, and exhibit a higher level of diversity and variability.

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FOOD WEBS OF ARCTIC LAGOONS: COMPARATIVE STUDIES FROM OPEN-WATER AND ICE-COVERED PERIODS

Coastal lagoons of the eastern Beaufort Sea are extraordinarily important habitat for an array of organisms of enormous ecological and subsistence value. Their unique physiography, a product of physical processes driven by ice, sediment transport, and freshwater inflows produce diverse systems that serve as nursery grounds for anadromous fishes and feeding grounds for over 150 species of migratory birds. These lagoons also receive large quantities of terrestrial organic matter through river discharge and shoreline erosion that is thought to provide an important carbon subsidy (in addition to phytoplankton) that supports and maintains heterotrophic activity and lagoon food webs. Our current work focuses on a set of 12 field sites along the eastern Alaskan Beaufort Sea coast, from Barter Island to Demarcation Bay. Visits to these sites, both during the ice-covered and open-water periods, reveal high concentrations of sediment chlorophyll in late winter and early spring, nearly twice that measured during the summer months. HPLC analyses revealed a high proportion of diatom pigments (fucoxanthin). Stable isotopic analyses of infauna and epifaunal species have confirmed the significant assimilation of marine carbon during the period of ice-cover, with increasing dependence on terrestrial organic matter through the summer, contrary to our original hypotheses on the seasonal importance of autochthonous vs. allochthonous carbon sources to lagoon food webs. We also found that lagoon waters become hypersaline (43) and net heterotrophic (values to 25% oxygen saturation) during winter, before rebounding during the period of ice break-up to net autotrophic (>100% saturation). Measurements of water and sediment chemistry, benthic and water column community characteristics, and natural abundance isotopic tracers promise to reveal the dynamic nature of these productive lagoon ecosystems under different hydrologic conditions.

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SEAGRASS LEAF SPECTRAL REFLECTANCE INDICATES SPECIES RESILIENCE TO LIGHT AND TIDAL VARIATION

Spectral reflectance (*R*) is an apparent bio-optical property that in photosynthetic organisms varies in response to changes in pigments. Because pigments serve either photosynthetic or photoprotective functions, *R* may reflect relative photosynthetic efficiency/capacity. Thus, *R* is may be used as an indicator of plant physiological resilience. Our previous work on corals and seagrass seedlings indicated that *R* exhibits population-based changes in response to salinity and light stress. This presentation will focus on variation in *R* in response to diurnal variation in irradiance, light reduction and desiccation stress in two seagrass species. Measurements of *R* were obtained in situ, using a field-compatible 25m-long reflectance probe connected to an Ocean Optics spectrometer and Toughbook PC. Multidimensional scaling analysis of diurnal variation in *R* between the large-bodied *Thalassia hemprichii* and the small-bodied *Halophila ovalis*, indicated that reflectance spectra were distinct between species with only 80% similarity, but were not significantly different (95% similarity) within-species among differing times of the day. Comparisons of *R* between shaded (60-75% reduction) and unshaded plots indicated there was a shading effect, which was greatest at mid-day. *T. hemprichii* exhibited greater diurnal and shading-related variation in *R* than *H. ovalis*. Measurements of leaves during low tide indicated that low-tide exposure also affected *R* in *T. hemprichii* to a greater extent than *H. ovalis*, which may be due to the former species' stiffer, more-erect leaves, which may make *T. hemprichii* less resilient to dessication stress. These preliminary data indicate that *R* may provide a non-invasive method that is sensitive to changes in seagrass physiological condition, but may be less sensitive than PAM fluorometry to diurnal variation.

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RESIDUAL CIRCULATION AND SEDIMENT TRANSPORT IN THE DUTCH WADDEN SEA

The Dutch Wadden Sea, situated between continental Europe and the Dutch Wadden Islands, is a semi enclosed basin connected to the North Sea by a series of tidal inlets and composed mainly of tidal flats and sea gullies. It is of high ecological importance due to its biodiversity and has been declared a World Heritage site by UNESCO. However, the system is under important pressure: regional relative sea level rise due to global sea level rise, postglacial rebound, polder drainage, and gas exploitation might permanent submerge the intertidal areas: the feeding ground for migratory birds. The only process able to change this fate is a mean rise of the Wadden Sea bottom due to net sediment flux. In order to calculate the net flux of suspended sediment into the Dutch Wadden Sea from the North Sea, realistic high resolution three-dimensional numerical simulations have been carried out using two different numerical models: the General Estuarine Transport Model (GETM) and Delft3D. The hydrodynamics, and hence, the transport of suspended particulate matter (SPM) are mainly governed by the tides and the fresh water discharge from the sluices in the Afsluitdijk, which have a highly variable discharge rate. Hence, special care has been put to reproduce the propagation of the tidal wave and the discharge at the sluices as close to reality as possible. For validation, the results are compared against different observational data sets. In addition, the results of the two models are compared against each other for benchmarking. SPM transport is modeled for five different sediment classes defined by the critical shear stress and the sinking velocity. First estimates on the total sediment fluxes will be presented together with an analysis on their variability and sensibility to the external forcing.

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PRESENCE OF SUBMERGED AQUATIC WEED *EGERIA DENSA* AS A FUNCTION OF WATER DEPTH AND FLOW

Of the many varieties of invasive submerged aquatic vegetation, Egeria densa has proved to be a chief ecosystem engineer in the Sacramento - San Joaquin Delta. Because it grows in dense patches, it slows water flow and removes sediment from the water column, increasing secchi depth and foraging opportunities to visual predators, while decreasing functional habitat for native species. Concerns about the nature of E. densa invasion and distribution have concerned managers in the SSJ Delta because it may significantly alter the functioning of subtidal habitat restoration projects. We use data collected in 2007 on E. densa distribution to show that infestation is a function of water depth and flow, and that this

knowledge can be built into restoration projects to make them more robust against future invasions of this particular species of aquatic vegetation.

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PREDICTING THE EFFECTS OF CLIMATE CHANGE ON *HEMIGRAPSUS SANGUINEUS* POPULATIONS IN INTERTIDAL COBBLE BEACHES

In only 25 years, the Asian shore crab, Hemigrapsus sanguineus, has invaded and become established along the eastern US coast. It has likely displaced previously established species and greatly impacted local food webs. Unfortunately, environmental factors that affect the distribution and density of this invasive species are not fully understood. In this study we identify environmental and substrate factors that affect H. sanguineus density and use the results to infer the potential response of this species to future changes in climate. We analyzed water quality, weather, crab density, and substrate data collected from 2008 to 2012 at four sites around Prudence Island, Rhode Island. Crab and substrate monitoring was conducted monthly from June to October around low tide. A generalized additive model (GAM) with Gaussian distribution errors was used to explore nonlinear relationships between H. sanguineus density and abiotic and substrate data. Percent deviance explained, as well as variables' relative influence (percentage of the contribution to the deviance reduction) were calculated. One-Way ANOVA was used to determine significant differences in substrate characteristics among sites. The GAM fits explained 76% of the deviance in the model. The three variables that contributed the most to the percentage explanation of the deviance were year (43%), site (15%) and cobble (13%); the least influential (<1%) were gravel, shell, and PAR. Our results showed that habitats with significantly higher percent cobble and significantly lower salinity had significantly higher crab densities (ANOVA, $P<0.001$). The long-term data sets analyzed provided valuable insights into the ecology of H. sanguineus. According to predicted climate change scenarios of higher temperatures and more precipitation (hence lower salinities) in RI, we might expect that invasive species like H. sanguineus will be more prevalent as the climate changes, as long as the proper habitat is available.

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ASSESSING THE CONDITION OF PUGET SOUND SEDIMENTS AS PART OF WASHINGTON STATE'S PUGET SOUND ECOSYSTEM MONITORING PROGRAM: CHANGES IN SEDIMENT QUALITY FROM 1997 TO THE PRESENT, INCLUDING DECLINES IN BENTHIC INVERTEBRATE CONDITION

Sediment quality condition in Puget Sound has been monitored since 1997 using a probabilistic survey design similar to that of the USEPA's National Coastal Condition Assessment. As part of the Puget Sound Ecosystem Monitoring Program, the Washington State Department of Ecology analyzes data from this large-scale status and trends survey to characterize sediments in eight regions and six urban bays Sound-wide. Indices of sediment contamination (Chemistry Index), laboratory toxicity tests (Toxicity Index), sediment-dwelling invertebrate community condition (Benthic Index), and a combined Sediment Quality Triad Index have been developed, with values calculated for each region and bay. Changes over time are noted for those areas which have been resampled. While no significant changes have been observed in the Chemistry Index, statistically significant declines have been recorded for both the Toxicity and Benthic Index for many regions and bays. These biotic responses are likely due to variables other than the individually measured chemicals. Changes in benthic community structure are highlighted for several study areas, and thoughts about the environmental stressors that may be triggering these changes will be discussed.

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RETHINKING THE FRESHWATER EEL: SALT MARSH TROPHIC SUPPORT OF THE AMERICAN EEL, *ANGUILLA ROSTRATA*

American eels (*Anguilla rostrata*) are frequently captured in New England salt marshes yet little is known about eel use of these habitats. Furthermore, road construction along coastal corridors has led to restricted tides and reduced tidal inundation which may limit the quality and availability of trophic resources for fish. To examine *A. rostrata* use of salt marsh habitats, samples of *A. rostrata*, organic matter and potential prey were collected from upstream and downstream regions of salt marshes with restricted and unrestricted hydrologic regimes. Stable isotope data were analyzed to evaluate the functional equivalency of both restricted and unrestricted salt marshes in the support of *A. rostrata*. Preliminary results suggest $\delta^{13}C$ values varied between upstream and downstream sampling sites regardless of the hydrologic regime of the site. More depleted $\delta^{13}C$ values found upstream reflect the influence of terrestrial vegetation and brackish water species such as *Phragmites* and *Typha*. The trophic level of *A. rostrata* was infuenced by the hydrologic regime interacting with upstream/downstream location. A post-hoc test indicated that fish captured in the upstream region of the reference marsh occupied a significantly higher trophic level than those captured upstream of undersized culverts. We found that salt marshes play an important role in the trophic support of *A. rostrata*. However, decreased prey diversity in upstream areas of restricted marshes may result in a degraded trophic structure where top predators such as *A. rostrata* feed at a lower trophic level than in unrestricted marshes.

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MODELING THE IMPACT OF LARVAL BEHAVIOR ON DISPERSAL AND CONNECTIVITY ALONG THE U.S. WEST COAST

We use a realistic ocean circulation model for the California Current System to investigate how larval behavior influences transport of nearshore marine populations. An implementation of the Regional Ocean Modeling System at 1/30 degree resolution and spanning the North American coast from northern Mexico to southern Canada provides realistic physical fields that drive offline larval dispersal calculations for the period from 2000 through 2007. We assume a 30-60 day competency period and investigated five idealized larval behaviors relative to passive, non-behavioral drifters. Larvae were programmed to (1) stay within 10 m of the surface, (2) stay between 25 m and 35 m, (3) undergo diel vertical migration between the upper 10 m and 25-35 m depths, (4) undergo ontogenetic or (5) reverse ontogenetic vertical migration between these depths. Focusing on springtime larval release, behavior has dramatic quantitative and qualitative impact on the maintenance of nearshore populations, with nearshore concentrations varying by over 2 orders of magnitude at 30 days following release. Nearshore retention is maximum or minimum for organisms that maintain their position entirely beneath or within the surface mixed layer, respectively, with intermediate retention levels for behaviors that experience both regions. Despite near surface larvae having overall low connectivity, these organisms nonetheless exhibit hotspots of settlement, particularly the Southern California Bight, Monterey Bay, and the region between Cape Mendocino and Heceta Bank. Thus, these widespread larval behaviors can have pronounced affects on larval dispersal with important implications for understanding and managing marine populations.

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ELUCIDATING THE RESPONSE OF MICROBIAL NITROGEN FIXATION IN SEDIMENTS TO EUTROPHICATION-INDUCED HYPOXIA

As anthropogenic nitrogen (N) inputs continue to increase with the U.S. coastal population, the subsequent N surplus exacerbates hypoxic conditions. Hypoxia, defined as less than or equal to 2.0 mg L^{-1} dissolved oxygen (DO), has been recorded globally in over 400 systems and is increasing in prevalence. Many of these systems, including Narragansett Bay, RI, experience eutrophication-driven hypoxia. This study investigated impacts of hypoxic stress on microbes that drive N_2 fixation in sediments, and thus, may be an additional source of N input to benthic ecosystems. In hypoxic zones, little to no oxygen penetrates the sediment, extending anoxic regions and the niche for anaerobic microorganisms. The Jenkins lab previously demonstrated that anaerobes related to sulfate and sulfur reducers have the potential to fix N_2 in Narragansett Bay, as indicated by the detection of active gene expression of a subunit of the protein catalyzing N_2 fixation, the nitrogenase iron protein (*nifH*). Interestingly, there is a correlation between severely hypoxic conditions and an increase in *nifH* expression in estuarine sediments. To further elucidate the relationship between hypoxic stress and microbial N_2 fixation, two seasons of incubation experiments were performed at the U.S. Environmental Protection Agency, Atlantic Ecology Division laboratory (Narragansett, RI). Narragansett Bay sediment cores were incubated under climatically relevant temperature and DO conditions. Higher *nifH* expression was detected in cores held at 19°C than 16°C. Down core concentrations of oxygen and hydrogen

sulfide, which influence microbial distribution and activity, were measured throughout the incubation. These biogeochemical profiles were compared to down core *nifH* gene abundance and expression measured at three time points. This study compared the community composition and activity level of *nifH*-containing bacteria under varying DO levels to elucidate the response of N_2 fixing bacteria to hypoxia.

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ECOLOGICAL RESEARCH ON *SPARTINA DENSIFLORA* INVASION AND REMOVAL AT HUMBOLDT BAY, CALIFORNIA

Ecological research on the invasive cordgrass *Spartina densiflora* at Humboldt Bay, California, demonstrates the impacts of invasion on native salt marsh communities and the response following *S. densiflora* removal. In recent investigations, *S. densiflora* marsh had lower net ecosystem productivity, despite its higher above-ground biomass, than native salt marsh; *S. densiflora* invasion lowered both algal biomass and functional group diversity, with implications for resulting trophic cascades; and invaded sites had lower diversity and abundance of terrestrial invertebrates than restored sites. *S. densiflora* was shown to have extremely high fecundity (86-116 million seeds/ha), and a persistent seed bank lasting at least two years; seed bank density ranged from 1-38 million seeds/ha, with indications that seeds may primarily enter the bank at the site of seed production. These research results and on-going investigations are guiding a regional *S. densiflora* eradication program.

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TEMPORAL DYNAMICS OF THE DOMINANT ZOOPLANKTON IN THE TIDAL-FRESHWATER JAMES RIVER (1986-2002 AND 2013)

Using archived and newly acquired data, we explore the seasonal and inter-annual dynamics of the dominant zooplankton species occurring at a fixed station in the tidal-freshwater James River (Chesapeake Bay Program monitoring station TF5.5). Three dominant zooplankton taxa were identified, the copepod *Eurytemora affinis*, the cladoceran *Bosmina longirostris*, and the rotifer *Brachionus calyciflorus*. Maximum abundances of *E. affinis* typically occurred in late spring (April-June) when water temperatures were near 25°C. Large abundance maxima also occurred during winter (November-January) in several years, when water temperatures were <10°C. The occurrence of these large winter blooms was coincident with lower than average water temperature in the month preceding the bloom, higher than average temperature during the bloom, or both. The cladoceran *B. longirostris* reached maximum abundances in the summer and early fall (June-November). High abundances also occurred during several years in late winter and spring, coincident with higher than average winter water temperature. A similar pattern of maximum abundances in the summer and early fall was observed for the rotifer *B. calyciflorus*. The available data will be used to characterize long term trends in the timing and magnitude of seasonal abundance maxima, and relate these to environmental conditions including climatological indices, water temperature, freshwater discharge, water clarity, chlorophyll-*a* and other indices of food availability.

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ASSESSING ECOLOGICAL COMMUNITY HEALTH IN COASTAL ESTUARINE SYSTEMS IMPACTED BY MULTIPLE STRESSORS

Increasing population pressure, urbanization of the coastal zone and nutrient and sediment run-off from agriculture and forestry has increased the number of large-scale and chronic impacts effecting coastal and estuarine systems. The need to assess cumulative impacts is a major reason for the current desire of managers and ecologists to define ecosystem "health" and "stress". A number of univariate metrics have been proposed to monitor health including indicator species, indicator ratios and diversity or contaminant metrics. Alternatively, multivariate methods can be used to test for changes in community structure due to stress. In this study we developed Benthic Health Models using statistical ordination techniques to identify key stressors affecting the 'health' of macrofaunal communities. Macrofaunal and associated environmental samples were collected across 75 sites from within Tauranga Harbour, which is a large estuary (approximately 200 km2) located on New Zealand's North Island. Distance-based linear modelling identified sediments, nutrients and heavy metals as key 'stressors' affecting the ecology of the harbour. Therefore, three multivariate models were developed based on the variability in community composition using canonical analysis of principal coordinates (CAP). In general, the multivariate models were found to be more sensitive to changing environmental health than simple univariate measures along an ecological gradient. This multivariate approach, first utilised by Auckland Council, can be used as a management or monitoring tool where sites are repeatedly sampled over time and tracked to determine whether the communities are moving towards a more healthy or unhealthy state. Ultimately such statistical models provide a tool to forecast the distribution and abundance of species associated with habitat change and should enable long term degradative change from multiple disturbances to be assessed.

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COMPARISON OF *FUSARIUM* SPP. COMPOSITION BETWEEN STRESSED AND HEALTHY *SPARTINA* SPP. IN ATLANTIC MARSHES IN NORTH AND SOUTH AMERICA

We sampled *Spartina alterniflora* in Connecticut, US and *S. alterniflora* and *S. densiflora* in Argentina to determine the incidence of *Fusarium*, an endophytic/pathogenic fungus associated with stressed plants. Plants including roots were removed and washed free of soil. Surface-disinfested stem and root pieces were placed on selective agar and incubated for 5-7 days. Colonies originating from single spores were sub-cultured and identified to morphological species. In North American marshes, two species of *Fusarium* predominated on *S. alterniflora*, *F. palustre* and *F. incarnatum*-like species. The incidence of these species was much higher on plants from sites where dieback occurred, but both species were found in similar proportion on healthy plants. In Argentinia, the incidence of *Fusarium* did not differ between any of the six sites or between the two *Spartina* species or whether they were stressed or not. In addition, the incidence of *F. palustre* was between 6-23%, whereas *F. incarnatum*-like species were not found. Four unfamiliar species were observed on these plants and may represent new species. The incidence of *Fusarium* on *S. densiflora* did not differ from *S. alterniflora* except. that *F. palustre* was not found on *S. densiflora*, which is consistent with a current hypothesis that *F. palustre* has a strong association with *S. alterniflora*.

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EFFECTS OF PHYSICAL MANIPULATION ON ACCRETION PROCESSES IN SALT MARSHES

A large proportion of the world's salt marshes have been subject to direct physical alterations including impoundment, ditching, farming, ditch-plugging and more recently increasing the area of open water in the marsh interior. Given an increase in the rate of sea level rise, and a limit to salt marsh vertical development, it is important that we understand how the manipulation of marshes affect accretion processes. Tidal flooding and sediment deposition are integral to salt marsh function including productivity, carbon and nutrient burial, accretion and elevation change, yet it is unknown how increased interior open water affects these processes. Along the mid- and north Atlantic coast of the U.S. over 90% of salt marshes have been ditched with an increase in the direct conversion of vegetated marsh to shallow pools. Paired salt marshes in Plum Island Sound, MA and Barnegat Bay, NJ were used to examine differences between ditched and increased open water areas on flooding, salinity, soil and porewater chemistry, and short-term sedimentation, accretion and elevation change rates. The creation of open water through the excavation of pools with and without enhancement by levees resulted in a reduction in marsh accretion process rates from that of ditched marshes. The restriction of ebb flow with levees in the open water area in Plum Island created a higher salinity and sulfide porewater environment and lower elevation change than in the ditched area. Despite being 14 cm lower in elevation, the ditched area had higher marsh plant species and greater drainage than the open water area. In Barnegat Bay, the marsh area with pools and ditches had less sediment deposition on the marsh surface and less accretion and elevation change than the ditched area. Thus, increasing the area of open water in the marsh interior had negative consequences on accretion processes compared to ditched marshes with the mechanisms inducing the difference site- and treatment-specific.

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THE CARBON SINK POTENTIAL OF SHELLFISH AQUACULTURE

The coastal carbon (C) sink is based on sequestration by marine vegetation and termed "blue carbon". However, there are other possible sinks, including shellfish aquaculture, which is a growing industry at local, regional, and global scales. In relation to the C budget of an entire system, shelled aquaculture species serve as long-term C repositories, assuming the shells are not returned to the system. We estimate this sink for hard clams (*Mercenaria*

mercenaria) and eastern oysters (*Crassostrea virginica*) for an intensive aquaculture site, the state of Virginia, and the United States based on reported harvests and shell weights. In the intensive aquaculture site (Cherrystone Creek, Virginia), we estimate that in 2011 and 2012 the annual harvest of over 30 million hard clams and eastern oysters resulted in the removal of about 92 Mg C each year. This corresponds to an areal removal rate of 625 ± 31 g C m^{-2} yr^{-1} (n=2). Aquaculture harvests in Virginia yielded an estimated C removal of 748 Mg C in 2012. Total hard clam and eastern oyster harvests for the United States for the most recent year of record (2005) removed an estimated 2,413-3,235 Mg C (range based on clam sizes). The amount of C removed is likely underestimated due to unrecorded public harvests and the harvesting of many other species which incorporate C into shell material. This previously un-quantified "shell" sink (living biomass excluded) is frequently larger than other "blue carbon" sinks on an areal basis and has the potential to persist on century or greater timescales, depending on the location of final deposition. Shellfish aquaculture also provides nutritional and economic benefits in addition to improved water quality through filter feeding. As coastal marine sinks decline globally due to the loss of seagrasses, salt marshes, and mangroves, the shellfish industry provides a partially compensatory, sustainable, and increasing C sink.

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IMPACT OF REMEDIATION EFFORTS ON THE DIVERSITY OF SANDY BEACH MICROBIAL COMMUNITIES FOLLOWING THE GULF OF MEXICO OIL SPILL

Sandy beaches are dynamic zones parallel to the shoreline where high energy, open ocean unconsolidated sediments are deposited and reworked. Sandy beaches are critical to coastal ecosystem biodiversity and are valued for recreational tourism. Prior to the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, the diversity of Gulf supratidal beach sediment microbial communities was poorly known. It was unclear how the microbial communities would respond to oiling, or to remediation efforts, such as sand washing and sediment redistribution. Supratidal to subtidal transects perpendicular to the shoreline, some from disturbed and remediated areas and others from undisturbed areas following the oil spill, were sampled from Dauphin Island, Alabama (USA). Microbial diversity was assessed from 0-10 cm depth using 16S rRNA gene pyrosequencing. Pre-spill results provided general information about the communities. Dune sediments had lower diversity than locations closer to the water, and the foreshore open beach had greater diversity than the backshore sediments. Over time, compositional shifts correlated to statistically significant changes in grain size and environmental variables such as organic carbon, water content, and pH. The most significant changes in grain size (and microbial diversity) correlated to where remediation efforts focused, specifically where sediments were sand washed or replaced. Microbial diversity from undisturbed areas had more constant structure over time. This research expands our current knowledge of supratidal sandy beach microbes and provides some indication that the communities can be resilient to habitat changes over time. However, the results also demonstrate that remediation efforts to clean beaches, whether after an oil spill or as routine management for recreational use, likely induce microbial community changes. The impact that microbial level changes have on the diversity, function, and health of higher trophic levels is unknown.

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SCIENCE BASED ECOSYSTEM MANAGEMENT

Over the past decade's eutrophication has affected the water quality in coastal areas worldwide as well as ecosystem services, with changing benthic community and potential changing habitat for a number of organisms. Since the late 80'ties Denmark has been reducing nutrient loadings significantly and as part of the European Water Frame Work Directive, Denmark has increased the reductions once more aiming to obtain "Good Environmental Status" in coastal areas. The last reductions towards 2015 goals did, however, not get through parliament silently. The reductions were based on environmental goals estimated from relatively simple empiric models. Hence, the agricultural & aqua cultural society, NGO's (nature preserving, anglers etc.) as well as the scientific community all agreed on the need for much more science based ecosystem tools for future environmental management. The solution, however, is not trivial, and due to both the complexity of the environmental problems and the variety of stakeholders the Danish Ministry of the Environment and Nature Agency has joined national modeling skills to develop a set of empiric and dynamic modeling tools. Three groups were formed to address catchment, lakes and marine areas, and this talk will focus on the substantial work done in the development of an integrated coastal set of models. The main results shown is the outcome of these integrated marine models taking into account coastal processes and ecosystem services as sediment processes, sea grass, algae growth, oxygen depletion, etc. Also, we managed to quantify the national nutrient contributions compared to trans-boundary transport and atmospheric depositions, clearly identifying areas where most effects from local reductions will be expected and where not. Hence, the tools developed are expected to be important for the clarification of the environmental status, as well as setting realistic and differentiated goals for future actions within coastal areas.

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INCORPORATING ECOSYSTEM BASED MANAGEMENT PRINCIPLES AT THE LAND-SEA INTERFACE

Ocean and coastal practitioners work within existing financial constraints, jurisdictions, and legislative authorities to manage living coastal and marine resources while seeking to promote and maintain a healthy and productive coastal economy. Fulfilling this mandate necessitates incorporation of best available science, including ecosystem based management (EBM) into coastal and ocean management decisions. EBM principles for ocean and terrestrial ecosystems have developed separately in the scientific literature, however many of the management objectives and challenges are the same. In light of the increasing need to co-manage ocean and terrestrial ecosystems due to anthropogenic stressors at the land-sea interface, we synthesize a set of EBM principles for use in the land-sea context with particular emphasis on available legal and regulatory authorities. This talk will explore how challenging assumptions around legal authorities and available science and incorporating emerging data and methods into decision making and resource management can improve the overall health of our coastal and marine ecosystems for the benefit of current and future generations.

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MICROPLASTIC MARINE POLLUTION IN THE SURFACE WATERS OF THE GREAT LAKES WITH COMPARISONS TO THE NORTH ATLANTIC SUBTROPICAL GYRE

Plastic marine pollution in the Great Lakes of the United States has previously only been known from beach surveys. The result of an ~700 nautical mile (~1300 km) expedition through Lakes Superior, Huron and Erie during July 2012 demonstrates that plastic pollution is also present on the lake surfaces. Neuston samples were collected in 21 stations using a manta trawl with a 333μm mesh. Though the average abundance was approximately 43,000 microplastic particles/km2, Station 20 contained over 450,000 particles/km2, greater than all other stations combined. Scanning Electron Microscopy (SEM) analysis of the initially sorted samples identified nearly 20% of the particles were coal ash, though this percentage varied widely as the likely result of the proximity of stations to sources. Many microplastic particles were multi-colored spheres. These are suspected to be microbeads from consumer facial scrubs or other cleansers that contain polyethylene particles of similar size, shape, texture and composition. The data obtained for the Great Lakes are compared to 35 stations in the North Atlantic Subtropical Gyre, which contained no coal ash or microbeads. The abundance of larger particles in the N. Atlantic was typically greater than in the Great Lakes, and inversely true for smaller particles.

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THE USE OF GLOBAL CLIMATE MODELS, THE COASTAL STORM MODELING SYSTEM (COSMOS), AND A USER TOOL TO ASSESS THE FUTURE VULNERABILITY OF THE CALIFORNIA COAST

Coastal communities throughout the world will face increasing hazards risks as climate change results in sea level rise (SLR) and increased storminess. CoSMoS is a numerical modelling system that was developed to predict coastal flooding due to both sea level rise and storms driven by climate change. CoSMoS applies a predominantly deterministic framework to cover large geographic scales (100s to 1000s of kms) but with fine local resolution (~20s of meters), in order to provide emergency responders and coastal managers with future critical storm hazard information to increase public safety, mitigate physical and ecological damages, and more effectively manage and allocate their resources. The results of the latest Global Climate Models are fed into a global wave model to develop wave conditions for the U.S. West Coast through 2100. Those offshore wave conditions, combined with tides and storm surge, are modelled down to the local level using state-of-the-art numerical modeling tools to determine coastal water levels which are then projected onto a 2 m Digital Elevation Model to estimate the extent of flooding. This is performed for virtually every combination of anticipated SLR and storm conditions. Here we present the framework of the modeling system, the final results from a recently completed climate vulnerability study for the North-central California coast, as part of the Our Coast Our Project (OCOF) project, and a sophisticated online decision-support tool for coastal managers.

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INTERTIDAL HABITAT USE BY HORSESHOE CRABS DURING SPAWNING SEASON IN THE NORTHERN GULF OF MEXICO

The purpose of this project is to develop a habitat suitability model for horseshoe crabs (Limulus polyphemus) in a study area ranging from the Mobile Bay estuary, AL to Horn Island, MS in the northern Gulf of Mexico. The model will use remotely sensed and in situ data for environmental variables during 2011 and be validated with horseshoe crab presence/absence and abundance data from field surveys in 2012 and 2013. We hypothesize that habitat suitability will increase westward with increasing distance from the Mobile Bay estuary, primarily due to high watershed discharge from the Mobile-Tensaw river system, which is the 4th largest freshwater discharge in the U.S. While horseshoe crabs are common to estuarine systems, they are known to prefer salinity levels of 8-9 ppt or higher and shorelines with at least 35 cm of well-drained sandy beach for spawning. Preliminary data support this hypothesis, showing progressively larger numbers of horseshoe crabs in intertidal areas at sampling sites west of the Fort Morgan peninsula of Mobile Bay. Peak numbers of amplexed pairs, suggesting spawning activity, were found in late May to late June, consistent with peak spawning periods in other regions. M:F sex ratios were male dominated and increased from the east to the west, possibly indicating more mating competition in a more suitable habitat. Water temperature, salinity, water clarity, and dissolved oxygen data were also collected at each site to facilitate development of a multiple regression model to predict the abundance and distribution of horseshoe crabs in the central nGOM during spawning season. As climate change, severe storms, and catastrophic events such as the Deepwater Horizon Oil Spill continue to modify habitat and potentially threaten horseshoe crab populations in this relatively unstudied region, our model results will be valuable to inform habitat research, conservation, and management plans for horseshoe crabs in the region.

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JUNCUS ROEMERIANUS PATCH STABILITY AND COMMUNITY SHIFTS ACROSS A MARSH

Juncus roemerianus, black needlerush, is common in high marshes and in patches in low marshes along the Mid-Atlantic and southern USA. We postulated that *J. roemerianus* patches will remain relatively stable in the absence of disturbance and under normal variations in flooding across a marsh. Disturbance will occur from winter storms through wrack (dead plant material) deposition and promote plant community shifts. The borders of patches between *J. roemerianus* and other saltmarsh species within different areas of a salt marsh were tracked at Upper Philips Creek (UPC) in Virginia since 1990. UPC is located on the Delmarva Peninsula and is part of the Virginia Coast Reserve Long-Term Ecological Research (LTER) site. In 1990, eight 3 x 8 m permanent plots, which contained the interface between *J. roemerianus* and other species, were established throughout the UPC marsh. Two hundred squares within 1 x 2 m quadrats within the plots were assessed for ground cover. Every year from 1990 to 2013 ground cover was identified visually and non-destructively. Patch border dynamics depended on the location in the marsh. Expansion occurred at high marsh sites both away from and near a creek. Little to no expansion was observed at one low marsh site and a high marsh site bordering a hollow. Wrack reduced patch size at another low marsh site in 1994 without full recovery. This study helps better understand the geomorphic setting and context for this plant and helps determine the time scale of community changes associated with patches of *J. roemerianus*. It also helps understanding of the long-term effect of sea-level rise versus wrack disturbance.

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ESTUARINE SHORELINE DYNAMICS: INSIGHTS FROM THE ALBEMARLE-PAMLICO ESTUARINE SYSTEM, NORTH CAROLINA, USA

Historically, coastal management and shoreline studies have focused on oceanfront shorelines. With over 18,000 km of estuarine shoreline in North Carolina, the vast majority (~97%) of the coast is not oceanfront. Within the Albemarle-Pamlico Estuarine System (APES) alone, there is 7,815 km or about 42% of the State's shoreline. The dynamics of estuarine shorelines are mediated by a complex interplay of natural processes and human activities. This study examined estuarine shoreline change over multiple temporal and spatial scales as well as the role of erosion in sediment budgets and the potential impacts of shoreline hardening on the dynamics of the system. The study utilized balloon-aerial-photography, real-time kinematic GPS, and heads-up digitizing to quantify shoreline erosion and modification. Wave action as a driver of shoreline change was explored using the coupled hydrodynamic Delft3D and SWAN model, and sedimentation was characterized using the radionuclide tracers of 210Pb and 137Cs. Decadal and historical (fifty-year) average rates of shoreline change across the system were similar, approximately -0.5 m yr-1 (ranging 0.6 - 1.2 m yr-1). Short-term (sub-annual) rates were highly variable and influenced by the passage of coastal storms, local wind directions, and shoreline type. Erosion of muddy (wetland) shorelines within the sub-estuary was found to contribute 30% of the incoming fine sediment to the system; the other 70% was provided by the Tar River. A little over half of this fine sediment, 59%, is estimated to be stored within the sub-estuary, while approximately 40% is exported to the adjacent Pamlico Sound. Observations of change in shoreline type were also documented for the Tar-Pamlico sub-estuary with an increase of modified (hardened) shoreline by 7.8% and an accompanying loss of natural shoreline.

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ENTRY LEVEL SONAR – IMAGING AND REMOVING MARINE DEBRIS USING LOW COST SYSTEMS

Low cost sonar systems initially developed for the freshwater fishing industry can be cost-effective tools for the implementation of small scale marine debris removal programs. Where the utilization of scientific-grade sonar by debris recovery teams is not operationally or fiscally feasible, low cost side-imaging instruments can provide for effective programming, especially in small, shallow estuaries. Combining these instruments with the working knowledge of local commercial fishers in New Jersey estuaries allowed researchers to partner with this sector and recover >550 derelict crab pots over a three month period using low-cost, readily available and easy-to-use sonar systems. Commercial fishers possess a local knowledge base that can be an excellent source for pre-planning and implementing cost effective marine debris (removal) programs, further contributing to the effectiveness of entry level sonar use. Researchers and commercial fishers worked together to develop Best Management Practices (BMP) for non-scientist groups on the use of low-cost side scan sonar systems for debris identification in shallow estuaries (<5m). Individual preferences and experiences of the participants in this project contributed to the development of multiple techniques for the management and on site use of sonar data by non-scientist groups. Participants also contributed significantly to the development of preferred retrieval methods and BMPs were specifically developed for derelict gear removal in smaller, shallow estuaries where silting in of marine debris can present a significant removal challenge. Additional benefits aimed at decreasing the loss of commercial fishing gear were realized when the consistent in-season use of low cost side-imaging sonars by commercial fishers was adopted. The final product of the NOAA-funded program will be a training DVD geared toward transferring implementation knowledge to other estuarine groups.

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WHERE'S THE GROUND SURFACE? – ELEVATION BIAS IN LIDAR-DERIVED DIGITAL ELEVATION MODELS DUE TO DENSE VEGETATION IN OREGON TIDAL MARSHES

Light Detection and Ranging (LIDAR) is a powerful resource for coastal and wetland managers and its use is increasing. Vegetation density and other land cover characteristics influence the accuracy of LIDAR-derived ground surface digital elevation models; however the degree to which wetland land cover biases LIDAR estimates of the ground surface is unknown. We investigated LIDAR interference by tidal vegetation across seven Oregon estuaries and twelve common wetland types using survey-grade Global Positioning System (GPS) measurements of the wetland surface and quantitative vegetation data (percent cover by species) for each measurement location. Our results suggest that LIDAR estimates of the ground surface in tidal wetlands are typically 15 – 30 cm above GPS measurements of the wetland surface. Plant associations dominated by Carex obnupta and Carex lyngbyei exhibited the largest discrepancy between GPS and LIDAR measurements (mean discrepancies 54 cm and 36 cm respectively). The smallest errors observed in the study were about 9 cm and occurred in several different plant associations including a low to middle salt marsh association dominated by a mixture of Deschampsia cespitosa, Distichlis spicata, Sarcocornia perennis and Jaumea carnosa. Our research yields new information for coastal LIDAR users and increases our understanding of uncertainty in LIDAR-derived datasets improving our ability to accurately evaluate and manage coastal environments.

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MARSH COLLAPSE DOES NOT REQUIRE SEA-LEVEL RISE

Sea level rise is often viewed as the main driver of salt marsh deterioration. However, while salt marshes can reach equilibrium along the vertical direction, they are inherently unstable along the horizontal direction. Marsh expansion driven by sediment supply rarely matches lateral erosion by waves, creating a dynamic landscape in continuous evolution. Recent results show that marsh collapse can occur in absence of sea level rise, if the rate at which sediments are eroded at marsh boundaries is higher than the input of sediments from nearby rivers or from the continental shelf. We therefore propose that the horizontal dynamics and related sediment fluxes are the key factors determining the survival of salt marshes. Only a complete sediment budget between salt marshes and nearby tidal flats can determine the fate of marshes at any given location, with sea-level rise being only one among many external drivers. This dynamics was very well known to ancient Venetians, who manipulated the supply of sediments to the Venice lagoon, Italy, in order to control the long-term evolution of the intertidal landscape.

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CONTROLS ON PARTICLE SETTLING VELOCITY AND BED ERODIBILITY IN THE PRESENCE OF MUDDY FLOCS AND PELLETS AS INFERRED BY ADVS, YORK RIVER ESTUARY, VIRGINIA, USA

A pronounced transition period in settling velocity (W_s) and bed erodibility (E) is observed seasonally in the middle reaches of the York River estuary, VA. In order to understand the processes controlling the temporal variability in W_s and E, water column hydrodynamics and bed stresses during a strong transition period were studied using a near-bed Acoustic Doppler Velocimeter (ADV). W_s and E appeared to be characterized by two distinct regimes with contrasting sediment and water column characteristics: (i) A physically dominated regime (Regime 1): a period dominated by flocculated muds (flocs) and (ii) A biologically-influenced regime (Regime 2): a period dominated by a mixture of biologically formed pellets plus flocs. During the floc-dominated Regime 1, W_s averaged about 0.5 mm/s, E averaged about 3 kg/m^2/Pa, and stress for initiation of erosion was only about 0.02 Pa. During the pellet-influenced Regime 2, average W_s increased to 1.5 mm/s, average E dropped to 1 kg/m^2/Pa, and stress for initiation of erosion increased to 0.05 Pa. Over a given tidal cycle, as bed stress (τ_b) decreased, the pellet component of the suspended sediment concentration (C) decreased relatively quickly, but the floc component of C did not decrease until τ_b was less than 0.08 Pa. This suggested that over individual tidal cycles, cohesion of flocs to the seabed was inhibited when τ_b exceeded about 0.08 Pa. Averaged over 25 hours, floc E on a given day was positively correlated to the magnitude of τ_b observed over the previous 5 days, providing an in situ estimate of a consolidation-relaxation time-scale for homogeneous estuarine mud. In contrast, E during periods strongly influenced by pellets was inversely correlated to τ_b with a zero time lag, which was more consistent with bed armoring. This suggested that under pellet-influenced conditions a muddy bed might behave relatively more like a non-cohesive bed.

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HOLOCENE SHORELINE CHANGES IN THE MAHANADI DELTA, INDIA: MANGROVE PALYNOLOGY

Mahanadi river delta in the north-eastern part of Indian coastline is a wave-dominated delta front.The shoreline changes since ~7 kyrs. and its effect on mangroves has been studied in a 17.5 m sediment core from Mahanadi delta using pollen as proxy data. On the basis of pollen/spores four phases representing climate and sea level fluctuations have been outlined. The bottom Phase 1 deposited between 7 to 6 kyrs. constitutes 41.7 % of the mangrove pollen out of 70.9 % of the evergreen tree pollen indicating high plant diversity supported by low seasonality and high precipitation. The Phase 2 represents dominance of fresh water aquatic pollen and in the subsequent Phase-3 which is of very short span (3.5 to 3.0 k yrs.) reveals low percentage of mangrove pollen. The top Phase-4 shows absence of arboreal pollen with an increase in non-arboreal pollen and the aquatic pollen. The above study points to deteriorating climatic conditions towards aridity affecting evergreen tree taxa. The altitude of the studied site is 13m above mean sea level and the evidences of palaeoshoreline is at the depth of ~12.5 m. Thus, the evidence of middle Holocene palaeoshoreline in the Mahanadi delta is almost at the present day sea level and ~30 km landwards from the present shoreline. The sediment accumulation since ~7 kyrs. is about 13m and the delta progradation is about 30km seawards. It has been recorded through different proxies that although the delta has prograded to about 25 to 30 km since middle Holocene all along the east coast of India but the evidence of middle Holocene palaeoshoreline is recorded at different depths in various deltaic sites. In the southern part (Cauvery delta) the evidence is below mean sea level, In Palar delta it is much above mean sea level and in the present studied site it is at the mean sea level. These differences are attributed to sediment discharge by the rivers in their respective deltas and neo-tectonic activities.

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THE IMPACT OF CRAB BIOTURBATION ON THE ERODIBILITY OF MARSH SEDIMENT AND THE INCISION OF TIDAL CREEKS

Understanding the potential response of salt marshes to sea-level rise (SLR) is critical to protecting and managing these valuable ecosystems. Along the US southeast-Atlantic coast, accelerating SLR may be driving rapid dissection of marsh platforms by formation and extension of tidal creeks. Current velocities alone cannot explain creek headward erosion rates >1.9 m/yr (Hughes et al, 2009). Vegetation dieoff zones at creek heads and ensuing channel incision coincide with concentrated burrows (>800/m^2) of the marsh crab *Sesarma reticulatum*. Field studies at Cape Romain, SC suggest that dieback of *Spartina alterniflora* is caused by intense crab bioturbation and attendant biomass decomposition and soil destabilization. These changes lead to the formation of a depression, which focuses tidal flow and enhances creek erosion (Wilson et al, 2012). Here we present supporting evidence at Sapelo Island, GA, indicating that this is not a site-specific process. Similar to trends at Cape Romain, surface soil bulk density decreases by 22% from the marsh platform to the dieoff areas (from 0.18±0.04 g/cm^3 to 0.14±0.04 g/cm^3) and redox potential increases by 140% (from 124.4±217.5 mV to 299.11±165.9 mV), reflecting both the increased void space and oxygenation due to burrowing. A 49% decrease in belowground biomass (from 9.8±2.9 g to 5.0±1.5 g) and a 24% decrease in shear strength (from 35.3±9.7 kPa to 26.7±19.4 kPa) indicate weakening of the soils because of destruction of plant rooting. A 23% decrease in elevation from the marsh platform (0.75±0.02 m above MSL) to the dieback areas (0.58±0.1 m) is consistent with the drop in creek head elevation measured in Cape Romain. This study is monitoring changes in marsh elevation, soil geochemistry, velocity distributions, and suspended sediment load. Upcoming laboratory flume experiments will measure changes in initiation of motion and suspended sediment load in order to further quantify the effects of burrowing on soil erodibility.

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NORTH CAROLINA SENTINEL SITE COOPERATIVE: PROGRESS AND LESSONS LEARNED

The North Carolina Sentinel Site Cooperative (NCSSC) was established in 2012 as part of a National Oceanic and Atmospheric Administration (NOAA)-wide effort to provide coastal communities and resource managers with information on the potential impacts of sea level rise on coastal habitats. NOAA established the Sentinel Site Program to utilize existing assets, programs, and resources to address coastal management issues of local, regional, and national significance through a place-based, issue-driven, and collaborative approach. The NCSSC developed a five year implementation plan in 2013 to guide the Cooperative's activities. One of the first activities of that plan was to conduct a research and monitoring workshop to document existing research and monitoring efforts and identify gaps. This talk will discuss the results of that workshop and the next steps being taken by the NCSSC to move forward in these difficult budget climates. Highlights will include the identified research and monitoring gaps, how we plan to grow the cooperative and update our implementation plan, and the barriers currently faced by the cooperative.

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OBSERVATIONS AND MODELING OF DYE TRACER RELEASES AT NEW RIVER INLET, NC, USA

Transport and mixing of tracers within and just outside of a small inlet with strong tidal currents (New River Inlet, NC) were observed with 7 ebb-tide fluorescent tracer dye releases during May 2012. The evolution of the dye plume depended on the tide stage, release duration and location, and waves and winds. Dye concentration and flux were measured at 15 locations with colocated current meters and fluorometers. Vertical profiles of dye, temperature, and salinity were measured at 2 locations. Surface maps of dye and temperature were made with 2 dye-sampling jetskis, CTD+dye casts were made from a small boat, and

vertical dye profiles outside of the inlet were obtained with a towed fluorometer-temperature array. Surface dye also was mapped with airborne hyperspectral imaging. The waves, currents, and dye tracer evolution was modeled with the COAWST modeling system, which couples SWAN (waves) and ROMS (currents, tracer). The offshore wave boundary is given by WW3, tidal boundary conditions are provided by the ADCIRC tidal database, and local winds are used to drive the model. Quantitative estimates of the observed dye transport will be described. Model simulations of the dye tracer field will be compared for a range of wave and wind conditions. The model allows investigation of the transport and fate of an ebb-tide inlet plume as inlet water encounters the ocean, including cross-shelf advection, return on flood tide, the role of waves, and the effect of vertical mixing. Staff and colleagues at SIO and WHOI assisted in collecting the field data, the USACE FRF obtained bathymetry, and the Office of Naval Research provided funding.

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IMPLICATIONS OF CALIFORNIA CURRENT HYPOXIA FOR WATER QUALITY MANAGEMENT IN SAN FRANCISCO BAY

Declining dissolved oxygen (DO) concentrations have been documented for California Current nearshore waters. These events can mostly be attributed to global processes that affect the deep ocean, as the west coast has natural circulation patterns that periodically draw these deep waters into shallow coastal areas. However, anthropogenic inputs may be influencing the rates of change in primary productivity and hypoxia to the extent to which the ecosystem encounters a tipping point of decline. These trends have important implications for San Francisco (SF) Bay, an estuary long recognized as one of the most nutrient-enriched of US estuaries. Two key science questions must be answered in order to inform water quality management in our region: 1) what is the volume of "natural hypoxia" associated with the advection of nearshore waters into SF Bay and how could increasing intrusion of low oxygen waters alter the rates of primary production and nutrient cycling in the Bay? 2) To what extent are anthropogenic nutrients exported from SF Bay contributing to the decline in nearshore DO? Both of these questions have key implications for water quality management in SF Bay. The SF Regional Water Quality Control Board has recently undertaken an effort to develop nutrient objectives for SF Bay. Our proposed approach involves linking ecological response indicators such as dissolved oxygen and phytoplankton abundance to nutrient loads and other environmental factors controlling response, using mechanistic modeling to accomplish this linkage. Science supporting our policy decisions should consider: 1) to what extent should nutrient loads to SF Bay be curtailed to avoid estuarine or nearshore tipping points, given projected climate change scenarios and 2) how factors outside of human control effect compliance with established objectives (e.g. DO). This talk will focus on the challenges of water quality management in the Bay, given data gaps and uncertainties in science.

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DRIVERS OF BACTERIAL COMMUNITY COMPOSITION IN ESTUARINE WATER COLUMNS AND SEDIMENTS: EXAMINING SEASONALITY AND NITROGEN LOAD IN WAQUOIT BAY, MA

Anthropogenic nitrogen additions are inducing eutrophication of coastal waterways worldwide. This has resulted in large-scale shifts in estuarine ecology including inducing macroalgal blooms, loss of eelgrass and anoxic conditions. However, the effect of eutrophication on microbial ecology is still unclear. Since microorganisms are responsible for the majority of nutrient cycling, including the cycling of nitrogen, understanding the changes that eutrophication has on microbial community composition is essential. To begin to understand these changes we analyzed microbial community composition within the six subestuaries of Waquoit Bay, East Falmouth, MA, USA over a seasonal cycle. Waquoit Bay offers a unique opportunity to study the effects of anthropogenic eutrophication as its six subestuaries span a range of urbanized land uses, resulting in differing nitrogen loads. We used pyrosequencing of the 16S rRNA gene to assess the microbial community composition in the sediments and water column of the six subestuaries. Initial analysis of the pyrosequencing data shows distinct water column and sediment microbial communities, with the sediment community showing much higher diversity than the water column. Principal coordinate analyses indicate that season is a driver of community composition in both the water column and sediments, with a stronger influence on water column community composition. Surprisingly, nitrogen load does not appear to be a strong driver of microbial community composition. However, rarefaction curves would suggest that there is much microbial diversity yet to be sampled within each subestuary. These results clearly add to our understanding of the effects of eutrophication on estuarine systems and raise future questions as to what shapes microbial communities.

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HOW DO EDAPHIC CHARACTERISTICS INFLUENCE NATIVE PACIFIC CORDGRASS RESTORATION SUCCESS ACROSS TIDAL ELEVATIONS?

Restoring native cordgrass *Spartina foliosa* is a critical step in restoring important ecosystem functions following eradication of invasive hybrid cordgrass in San Francisco Bay, CA. Among the most critical functions is providing nesting habitat for federally endangered California Clapper Rail as well as supporting numerous species as part of the benthic food web. We investigated the effects of tidal elevation (inundation), herbivory, sediment conditions, porewater salinity and porewater sulfide on the success of restoration planting of native *S. foliosa* transplants. Large scale outplanting occurred at three sites with dissimilar hydrology. Planting occurred along a gradient designed to test inundation limits to survivorship. Native cordgrass was planted in paired caged and uncaged plots to test the effect of herbivory. Growth and edaphic characteristics were monitored on a quarterly basis. Preliminary results indicated inundation time and caging to be significant factors in survivorship at two sites, but did not explain variation in survivorship at the third site. Sulfide and salinity varied across elevations and among sites; however, neither of these factors contributed to initial survivorship rates. Continuing research will likely detect an influence of salinity and sulfides by the end of summer 2013, as pilot plots had large spikes in mortality of plants correlated to August 2012 field soil conditions. Mean survivorship and the parameters that limited growth varied among marshes, and inundation and herbivory played an important role in survival . Understanding the limits on native cordgrass survival will aid the large-scale restoration efforts underway in San Francisco Bay.

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SCIENTIFIC TOOLS FOR SUSTAINABLE PORT DEVELOPMENT: PORT F RIO GRANDE, BRAZIL

In recent years, a combination between environmental and commercial demands, and the need for maintenance and expansion of the current Brazilian port infrastructure generated the need of expanding the existing structure. The main objective of this work is to integrate scientific tools for the evaluation of alternatives for expansion of Brazilian ports. A case study was carried out to validate the methodology and evaluate the conditions of navigability in the access channel to the Port of Rio Grande after the conclusion of the modernization work. The effect of the changes performed on the access channel to the Port of Rio Grande on the dynamics of the Patos Lagoon estuary was evaluated based on field data and numerical modeling of the new hydrodynamic conditions. Results indicated that specially at the mouth, a decrease (increase) in the intensities of flood (ebb) between the breakwaters occurred. Outside the breakwaters, the occurrence of a transversal current was intensified, making maneuvering in the area much more difficult. In order to establish the new navigation and safety conditions, the environmental conditions generated by the numerical model were used in a full mission bridge simulator. Results indicated that maneuvers were performed successfully for the established operational conditions, maintaining a good reserve with respect to the use of the rudder and engine for the daytime, night and fog periods. Maneuvering in critical conditions during flood events could not be carried out due to the difficulty of maintaining vessel position, and are also not recommended during ebb critical events. Results also indicated the necessity of modifying the profile of the access channel in order to increase safety. Results indicated that the integration of physical field data, numerical modelling techniques and real time simulations, composes a set of scientific tools for the evaluation of expansion alternatives in Brazilian ports.

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ON THE RELIABILITY, UNCERTAINTY, SCALING AND TRANSFERABILITY OF ECOLOGICAL PRODUCTION FUNCTIONS IN ECOLOGICAL PERIODIC TABLES

Ecological periodic tables are an information organizing system. Their elements are categorical habitat types. Their attributes are quantitative, predictably recurring (periodic) properties of a target biotic community. Since they translate habitats as inputs into measures of natural capital and ecosystem goods and services as outputs, ecological

periodic tables are also repositories of ecological production functions. Their foundational principle is the ecological tenet that the biophysical environment, that is, habitats structure biotic communities. They are a durable, open and flexible system that accommodates all operationally defined habitat types and biotic communities for which the periodicity of habitat usage patterns by a biotic community have been empirically substantiated. Their reliability is ensured when, in the discovery of quantitative, periodic natural patterns, data quality requirements with respect to the spatial and temporal scale, sampling design, sampling method and statistical power are met. Uncertainties in measurement variables are reported as statistics of dispersion. Rows and columns of elements ("blocks") differentiate quantitative, periodic habitat–community patterns that differ in different temporal (e.g., seasonal) or spatial (e.g., bioregions) domains. Ecological production functions are scale invariant in the time-space domains represented by each block and are not transferable between blocks.

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SEAGRASSNET: SEASONAL MONITORING OF TWO SEAGRASSES, *ZOSTERA MARINA* AND *ZOSTERA JAPONICA*, AT DUMAS BAY, WASHINGTON

SeagrassNet is a global seagrass monitoring program that is now established in 33 countries with 122 monitoring sites world-wide. Standardized protocols for scientific monitoring have been developed and area successfully implement by trained teams of local scientists and managers. Quarterly fixed-transect sampling is carried out at sites documenting seagrass species composition, cover, density, biomass, and canopy height, as well as temperature and light. Monitoring teams upload data via the internet to an online database and archive at www.SeagrassNet.org. The Washington State Department of Natural Resources' Nearshore Habitat Program established a SeagrassNet site at Dumas Bay located in Federal Way, WA in May 2008. Five years of sampling show seasonal patterns in all measured seagrass species (Zostera marina and Zostera japonica) parameters along each transect, established at +1m, 0m, and -1.6m MLLW. At the site level, seagrass is declining in cover and density with strongest losses documented at the +1m and -1.6m transects. The specific cause of declines is currently unknown but is likely due to a combination of environmental stressors including: reduced light availability, physical disturbances, changes in substrate and nutrient enrichment. Long-term assessment of seagrass resources elevates the visibility of this important nearshore habitat and provides a barometer of direct anthropogenic and global climate change impacts.

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ELUCIDATING TERRESTRIAL NUTRIENT SOURCES TO A COASTAL LAGOON, CHINCOTEAGUE BAY, MARYLAND, USA

Long-term non-linear ecosystem-scale changes in water quality and biotic communities in coastal lagoons have been associated with intensification of anthropogenic pressures. In light of incipient changes in Johnson Bay (an embayment of Chincoteague Bay, Maryland-Virginia, USA), examination of nitrogen sources was conducted through synoptic water quality monitoring, stable nitrogen isotope signatures (δ15N) of in situ bioindicators, and denitrification estimates. These data were placed in the context of long-term and broader spatial analyses. Despite various watershed protection efforts, multiyear summer time studies (2004-2007) suggested that high levels of terrestrially derived nutrients still enter Johnson Bay. Total nitrogen concentrations in Johnson Bay were 132% the concentrations in the broader Chincoteague Bay during the late 1970s (mean 2004-2007 was 40.0 to 73.2 μM). Comparing total nitrogen concentrations in Johnson Bay to St. Martin River (consistently the most eutrophic region of these coastal bays), Johnson Bay has increased from 62.5% to 82.5% of the concentrations in St. Martin River during the late 1970s. Though specific sources of nitrogen inputs have not yet been definitively identified, the long-term increase in total nitrogen concentrations occurred despite increased and continued conservation and protection measures. We suggest that investigating nutrient sources can reveal potentially ineffective nutrient policies and that this knowledge can be applied towards other coastal lagoons.

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CLIMATIC DRIVERS OF THE SAN FRANCISCO ESTUARY FISH ASSEMBLAGE

Estuaries are complex ecosystems with drivers that originate in watersheds and oceans which operate through different mechanisms at varying frequencies. Three decades of monthly observations of the fishes in the San Francisco Estuary have revealed new insights on how climatic drivers affect biological communities and abundance. Freshwater flow entering the estuary drives the community composition and abundance of fishes in the pelagic and demersal habitats in the upper estuary. Ocean conditions as index by the NPGO drive community composition and abundance of fishes in demersal but not pelagic habitats in the lower estuary. The response of fishes in pelagic habitats in the lower estuary has been dampened by drivers internal to the estuary. For example, ocean conditions drive the abundance of Northern anchovy, although an altered foodweb attributed to an introduced bivalve appears to have confined its distribution to the euhaline zone. Thus, complex interactions of climate forcing and internal factors drive community composition and abundance in estuaries.

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RESPONSES OF BENTHIC-PELAGIC COUPLING TO ANTHROPOGENIC AND CLIMATE-DRIVEN ECOSYSTEM CHANGES IN A TEMPERATE ESTUARY

Narragansett Bay, RI is a temperate estuary that exhibits strong north-south gradients of anthropogenic impacts, nutrients, and primary production. Recent mandates of tertiary wastewater treatment have begun to reduce the nutrient loading in the most impacted areas of the Bay (the Providence River Estuary) resulting in the first major changes in nitrogen loads since the 1970s. We measured benthic metabolism (oxygen uptake) and inorganic nutrient fluxes at the sediment-water interface to compare benthic-pelagic coupling dynamics at two stations near different extremes of this down-bay gradient. We also compared benthic flux measurements made intermittently over the last ~40 years in the Providence River Estuary to assess long-term variation in the face of imminent ecosystem changes. Despite the strong gradients in some of the drivers of benthic mineralization such as organic matter (phytoplankton biomass) and primary production, there was no such gradient in benthic fluxes of N or P between the upper (average DIN=166 $\mu mol\ m^{-2}\ h^{-1}$, DIP=7 $\mu mol\ m^{-2}\ h^{-1}$) and mid (average DIN=115 $\mu mol\ m^{-2}\ h^{-1}$, DIP=8 $\mu mol\ m^{-2}\ h^{-1}$) reaches of the Bay ($p>0.05$). This may be due to flushing of organic material down-bay before an excess amount falls to the benthos. Mean sediment oxygen uptake was significantly higher in the Providence River Estuary (1981 $\mu mol\ m^{-2}\ h^{-1}$) than in the mid-Bay (828 $\mu mol\ m^{-2}\ h^{-1}$; $p<0.0001$), and was the only measured parameter to have significantly increased in the Providence River Estuary over time (61% increase), especially during the last decade.

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CLIMATE CHANGE AND THE MANAGEMENT OF N EXPORT FROM URBAN CATCHMENTS TO AQUATIC ECOSYSTEMS: A WATERSHED APPROACH

Recent studies indicate that the Chesapeake Bay region will experience significant changes in climate forcings by the end of the 21st century. These changes include increases in CO_2 concentrations, sea level, and water temperature of 50 to 160%, 0.7 to 1.6 m, and 2 to 6 ºC, respectively. Moreover, changes in precipitation patterns are likely to increase the frequency and intensity of large storms. Although there are relatively large uncertainties associated with estimates of streamflow, predictions suggest an increase, especially in winter and spring flows. Because N processing in the landscape and aquatic ecosystems is strongly influenced by water residence time, the effects of increasing flows on the export of N to the estuary will be particularly apparent in urban areas where imperviousness has altered the pathway and quantity of water and N delivered to aquatic ecosystems. There are a number of effective best management practices (BMPs), such as regenerative stormwater conveyance systems (RSCs), that could be employed to mitigate increased N loading to the estuary. RSCs implemented in deeply incised stream gullies or as retrofits of existing stormwater structures show great potential as a means by which stormwater runoff and pollutant loads can be reduced before they reach stream channels and the estuary. Examples of the performance of RSCs and how to include these BMPs in the context of a watershed approach to stormwater management will be discussed.

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APPLICATION OF ROBUST DECISION MAKING FOR ADDRESSING CLIMATE CHANGE AND OTHER UNCERTAINTIES ON WATER QUALITY MANAGEMENT DECISIONS FOR THE CHESAPEAKE BAY

In this case study application, EPA, RAND, and the Chesapeake Bay Program are testing the effectiveness of Robust Decision Making (RDM) for addressing water quality management decisions in the face of climate change and other relevant uncertainties. The RDM approach explicitly recognizes and incorporates uncertainty into evaluation of alternative management decisions with the goal of identifying those strategies that are robust across the widest range of potential futures. The case study is focused on the Patuxent River, a tributary to the Chesapeake Bay located in eastern Maryland. The Patuxent watershed is 2,479 km2 in area, is highly urbanized, and has a rapidly growing population. We examine the contribution of stormwater contaminants from the Patuxent to the overall Total Maximum Daily Load (TMDL) for the Chesapeake Bay under multiple scenarios of changing land use, climate, and contaminant removal efficiencies for different suites of best management practices (BMPs). Contaminants considered are nitrogen, phosphorus, and sediment loads to the Bay. The assessment is based on a large set of scenario simulations using the Chesapeake Bay's Phase V watershed model. Uncertainties represented in the analysis include 12 land use scenarios with different population projections and development patterns, 18 climate change scenarios (based on 6 general circulation models and 3 alternative emissions paths), several future time periods, and alternative assumptions about BMP performance standards and efficiencies associated with different suites of stormwater BMPs. Finally, we develop cost estimates for each of the performance standards and compare cost to TMDL performance as a key tradeoff for future water quality management decisions. This case study will support the Chesapeake Bay Program in providing climate-related decision support for water quality management, and more generally help EPA assess the effectiveness of RDM to support water quality management.

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CONSERVATION ACTIONS ALONG INTERIOR RIVERS OF THE UNITED STATES - CONTRIBUTIONS TO THE RECOVERY OF A FEDERALLY LISTED BIRD SPECIES

The U.S. Army Engineer Research and Development Center, in collaboration with American Bird Conservancy, is conducting research on how to improve engineering practices to reduce conflicts with federally listed bird species, and to assist in species recovery. The US Army Corps of Engineers (USACE) conducts coastal shoreline protection, beach nourishment, and maintenance/operation of interior waterways for multiple uses. Dredged material resulting from these activities has been used extensively for habitat creation and the conservation of coastal and inland bird species, several of which are federally listed as threatened or endangered. Least Terns are colonial, fish-eating birds that nest on bare ground in a variety of open habitats on rivers and along coasts. The federally endangered interior population of Least Tern nests most frequently on sandbars behind dike fields on major rivers or, in the case of lock and dam navigation systems, where regular dredging to maintain navigation channels results in dredged material disposal to create habitat. We provide an overview of how the USACE and its partners are developing a comprehensive, range-wide conservation strategy to support recovery of an endangered species by: (1) using dredged material, river flows, and other engineering practices, within the framework of the USACE "Engineering with Nature" initiative, to create and maintain Least Tern habitat; (2) integrating Least Tern life-history information, along with dredging practices, river flow data, and habitat information, into regional and range-wide models; and (3) working with partners to develop regional collaborative conservation agreements. The ultimate objective is to bring these activities together in a coordinated fashion to promote long-term conservation and persistence of Least Terns, while simultaneously facilitating USACE authorized missions along navigable rivers.

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SEASONAL PATTERNS OF $\delta^{15}N$ AND $\delta^{18}O$ OF NO_3^- IN THE MURDERKILL RIVER WATERSHED AND ESTUARY, DE

The stable isotopes of dissolved nitrate ($\delta^{15}N_{NO}3^-$ and $\delta^{18}O_{NO}3^-$) together with nitrogen speciation can be used to track sources and to determine the processes controlling nitrogen attenuation. In the Murderkill Watershed that discharges to Delaware Bay, we see little systematic change in $NO3^-$ concentrations and isotopic composition in streams, but NO_3^- decreases and NO_3^- isotopes get heavier in ponds, consistent with plant uptake and/or denitrification. This effect is pronounced in summer months when the concentrations of NO_3^- and the NO_3^- to PO_4^{3-} ratio drop, consistent with nitrogen limitation. In the estuary, longitudinal mixing is rapid and NO_3^-concentrations are largely controlled by mixing between four sources: the watershed, Delaware Bay, wastewater effluent, and discharge from the salt marshes. Unlike the freshwater ponds, biogeochemical processes are of secondary importance in controlling nitrogen speciation and isotopic composition in the estuary. Of the various sources, wastewater is a minor component of the nitrogen mass balance relative to the watershed: the distinct isotopic composition of wastewater effluent has little effect on the isotopic composition of the estuarine waters. During the summer of 2012, there is evidence of NH_4^+ and DON addition to the estuary, most likely from marsh sources. During this period, $\delta^{18}O_{NO}3^-$ increases with increasing salinity but $\delta^{15}N_{NO}3^-$ does not; this suggests that some of the $NO3^-$ in the lower estuary is likely generated by nitrification of this NH_4^+ and DON. In late Fall 2012, nutrients are mostly conservative. Due to the significantly higher NO_3^- concentrations during the fall, there is little evidence of NO_3^- uptake and fractionation in the estuary. The above findings suggest that isotopic signatures and mixing analyses can be used to determine the relative importance of different physical and biogeochemical processes controlling nutrient distributions in contrasting watershed and estuarine settings.

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PHYTOPLANKTON AND NUTRIENT DYNAMICS IN AN URBANIZING, EUTROPHIC SUBTROPICAL ESTUARY (OSO BAY, TEXAS)

In this study we present the first two years of data from an ongoing study of water quality and phytoplankton dynamics in Oso Bay (Corpus Christi, TX). The watershed of Oso Bay has undergone significant urbanization over the past two decades, and Oso Bay itself currently exhibits several harmful symptoms of eutrophication. In this study, samples have been collected every 2-4 weeks, as well as at higher frequencies in response to storm events, from six sites varying in land use influence within Oso Bay since summer 2011. Results of this study suggest a relationship between watershed land use practices, nutrient and phytoplankton dynamics. As an example, prolonged, excessively dense phytoplankton blooms and presence of harmful algal bloom species are particularly common in areas of high anthropogenic influence and nutrient-rich effluent, such as near tributaries of a municipal wastewater plant and golf course. The relative influence of inorganic N and P on phytoplankton growth appears to vary on a seasonal basis in response to seasonal changes in temperature and precipitation, suggesting a necessity for controlling both N and P in order to reduce phytoplankton growth in the system.

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THE RELATIONSHIP BETWEEN BIODIVERSITY AND ECOSYSTEM FUNCTION IN A COASTAL WETLAND

The gradual loss of 90% of CTZs in California has motivated research aimed at understanding the effects of habitat loss on the remaining wetlands. Biodiversity-ecosystem function (BEF) has historically been investigated in terrestrial communities however these questions have not been fully explored in wetlands to date. Specifically, I plan to investigate the relationship between plant species diversity and ecosystem functioning in Colorado Lagoon, Long Beach, CA. By manipulating local salt marsh plant diversity, my research has been designed to answer three specific hypotheses. First, that increasing plant species diversity will result in increased primary productivity and increased resistance to invasion in experimental plots. Second, that observed species-specific variation in individual demographic parameters (e.g., survival and growth) will be correlated with variation in plot-level responses. Finally, that variation in plant demographic parameters and resulting ecosystem processes among treatment groups at a given level of species richness will be correlated with species-specific plant functional traits. I selected the following six common native mid-marsh species: Sarcocornia pacifica, Batis maritima, Distichlis spicata, Frankenia salina, Jaumea carnosa, and Distichlis littoralis. My experimental design will allow me to test my hypotheses which mainly suggest that overall wetland function will decline with a reduction in species diversity. Further by identifying traits associated with better (or worse) performing plots in the treatment groups, I will gain insight into the underlying mechanisms affecting primary productivity and resistance to invasion. Preliminary data indicate that there is a strong block effect throughout the experiment, but also that the higher diversity treatments have decreased mortality and increased occurrence of non-planted species. With time, I predict that species-specific traits will help explain these differences.

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A MODELING SYSTEM CONSTRUCTED TO DETERMINE FACTORS AFFECTING WATER QUALITY IN OLD TAMPA BAY, FLORIDA

Since the 1980's, significant reductions in point source nitrogen loads to the Tampa Bay system have resulted in improved water quality (in particular, reductions in phytoplankton biomass, improved water clarity) and subsequent expansion of seagrass beds). However, unlike the other six major segments, the Old Tampa Bay segment still shows periodic poor water quality conditions and limited expansion of seagrass beds. In order to effectively characterize the primary factors stressing Old Tampa Bay, a coupled watershed/ hydrodynamic/water quality/optics model of the bay has been constructed. The watershed model, INTB, is an integrated modeling system comprising the Hydrological Simulation Program-FORTRAN (HSPF), the Modular Three-Dimensional Finite-Difference Groundwater Flow Model (MODFLOW) and code coupling the two. The hydrodynamic and water quality modeling system comprises ECOM/RCA. The optical model is the empirical optical model originally developed by Kirk (1981). The watershed model provides runoff and groundwater flows and loadings to the hydrodynamic and water quality models, respectively, and the water quality model provides information (phytoplankton, total suspended solids and CDOM) to the optical model. The model has been calibrated to a 10-year (2000-2009) physical and water quality data set that spans dry, wet and average rainfall and freshwater inflows to the Tampa Bay system. Qualitative comparisons have also been made against a 2012 field program that measured light/dark sediment cores that illustrate the importance of benthic algae on nutrient cycling in the shallower portions of Old Tampa Bay. The model has also been applied in hind-cast mode, reproducing the major water quality conditions observed before the implementation of the point source nutrient reduction program. Output from the water quality model has been combined with an optics model to quantify the major factors contributing to light attenuation to the seagrass beds.

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WHERE DO ALL THE SURFERS GO? USING PARTICIPATORY MAPPING TO UNDERSTAND RECREATIONAL USE OF DELAWARE'S ATLANTIC OCEAN AND BAY

Delaware's Ocean and Bay are experiencing increasing pressures on its resources from the growing demand of human utilization. As traditional coastal and ocean uses expand and new uses emerge, managers are tasked with providing for the sustainable growth of current and future activities while ensuring the conservation of important marine resources. As such, it is critical that managers have the best available spatial and temporal information about both human activities and marine resources in order to make decisions that minimize impacts and conflicts. Spatial knowledge of many human uses within estuarine and marine environments is often held by a small number of individuals who routinely utilize these waters, making some human use patterns difficult to quantify. A participatory mapping workshop was held to capture spatial and temporal patterns of 21 recreational activities in the Delaware Bay and Atlantic Ocean. Workshop participants represented a variety of recreationally-based backgrounds and perspectives including fishers, boaters, paddlers, surfers, hunters, wildlife enthusiasts, ecotourism business owners, non-profits, and governments. Participants were largely identified through referrals from known stakeholders, and were recruited based on their ability to provide a comprehensive account of targeted recreational activities occurring in Delaware's waters. Several representatives of the same recreational activities were invited to ensure that comprehensive, consensus-based data sets were captured. Participants were broken into four workgroups representing a broad array of recreational uses, and asked to map where these activities take place using e-beam technology. Each workgroup mapped the same recreational uses, and notes were taken to capture additional temporal and cultural information. Composite maps were processed using ArcMap 10.1. This workshop provided a stakeholder driven process to better understand human use in Delaware's waters.

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BUILDING A COMMUNICATIONS NETWORK FOR ECOSYSTEM BASED MANAGEMENT: LESSONS LEARNED IN SOUTH FLORIDA

This presentation reviews our experience gathering, framing, and disseminating information about the South Florida coastal marine ecosystem in the MARES (MARine and Estuarine Goal Setting) project. The overriding goal of MARES is to get people thinking holistically about the region's coastal marine ecosystem. We adopted the approach of an integrated ecosystem assessment (IEA). The first half of the MARES project focused on gathering and framing information about the ecosystem involved scoping, using integrated conceptual ecosystem models, the development of ecosystem indicators, and risk analysis. In addition to forging a consensus view of the ecosystem, these activities lead participants through a continuum of learning and peer interactions that improves their ability to address risk and uncertainty in making decisions that affect the coastal marine environment. In the second half of the project the focus shifted to disseminating results. Several communication strategies continue to be used, including personal contacts, internal project reports, journal articles, factsheets, email listserver, project website, Facebook page, and posting digests of project reports to a blog site. While we can claim success related to building a consensus view of the ecosystem, results in achieving the goals of the IEA process have been mixed. MARES has been successful in building a network of partners who can work together to achieve common goals. In this, the MARES project can be regarded as continuing a series of interdisciplinary, interagency projects that have proven effective in building and maintaining a community of practice for ecosystem-based management of the South Florida coastal marine ecosystem. Lessons learned point to the importance of a communications strategy that begins with the start of the IEA process, the need for fluidity in implementation, and ongoing evaluation and adaptation to requirements and opportunities that can, and did, change rapidly.

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LACK OF EELGRASS RECOVERY IN A DANISH ESTUARY - EVALUATED BY FIELD EVIDENCE, MODELLING AND GIS-ANALYSIS

Eutrophication has in the past reduced eelgrass coverage in most Danish estuaries. Despite a significant reduction in nutrient loading during the last 20 years and oligotrophication in progress, eelgrass (Zostera marina L.) has not managed to recover. This lack of recovery is evident even in very shallow locations with sufficient light. EU's Water Frame Directive considers eelgrass is a key element for good ecological quality, but no Danish estuaries fulfill the EU criteria because of lacking eelgrass recovery. A national project, REELGRASS (2008-2012), was established to study processes and mechanisms that prevent the recovery of eelgrass. Field studies and laboratory experiments revealed that several mechanisms and processes explained the lack of eelgrass recovery despite sufficient water quality: 1) Eelgrass seedlings are easily uprooted in sediments with low anchoring capacity due to eutrophication driven organic enrichment; 2) space, which was eelgrass habitat in the past, is now occupied by macroalgae; 3) Ballistic effects of drifting macroalgae cause seedling loss by uprooting; 4) Sediment resuspension caused by macroalgae moving over the bottom maintains estuaries in a turbid state and prevents sufficient benthic light climate for eelgrass especially in deeper basins; 5) Eelgrass expansion in sandy areas is prevented by efficient burial of eelgrass seeds and seedlings through lugworm (Arenicola marina) bioturbation activities. All the identified mechanisms and processes were quantified experimentally and introduced into a 3D ecological model and associated GIS-tool. The outcome is a precise analysis of how much each of these stressors contribute to the lacking eelgrass recovery in different habitats varying in for instance nutrient loading, water depth and hydrodynamic conditions. The overall impact of these stressors is finally evaluated for an entire estuary (Odense Fjord).

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COMPARATIVE ECOTOXICOLOGY OF BENIGN AND TOXIGENIC ESTUARINE PHYTOPLANKTON RESPONSES TO AN AGRICULTURAL HERBICIDE

Despite the ubiquitous occurrence of atrazine in coastal watersheds, the ecotoxicological effects of this herbicide on estuarine phytoplankton are poorly known. We quantified the response of selected, ecologically important, cultured phytoplankton species to this common agricultural chemical at environmentally relevant concentrations, using combined toxicological and phycological laboratory techniques. The species tested thus far include Dunaliella tertiolecta (Chlorophyceae), Prymnesium parvum (Haptophyceae)

and Chattonella subsalsa (Raphidophyceae). Dunaliella spp. are benign, whereas the other two species are toxigenic and have caused major fish kills in estuarine and coastal waters. We have also quantified the extent to which nutrient supply ratios (N:P) can effect changes in the relative sensitivities of the selected species to atrazine exposure. Trials to date indicate the relative sensitivity of these species in replete media (in increasing order) is Dunaliella tertiolecta <Prymnesium parvum <Chattonella subsalsa. These findings suggest that, as expected, phytoplankton can vary in their sensitivity to this commonly occurring photosynthetic inhibitor and these differences can be observed along both phylogenetic and regional lines. Subsequent testing has examined the extent to which atrazine can facilitate dominance by harmful algal species (HABs) and related major fish kills in brackish waters by using hemolytic assays to examine the influence this environmental contaminant may have on toxin production in the potential HAB species. Preliminary results from these assays on the toxigenic species indicate a significant ($p<0.05$) uptick in the production of hemolytic compounds at environmentally relevant herbicide concentrations and a general trend toward decreased sensitivity to atrazine exposure in nutrient-stressed environments.

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THE PEARL OF THE OYSTER IS THE CARBON: COASTAL SHELLFISH REEFS AS SOURCES AND SINKS ON A BLUE CARBON SCALE

Recognizing the urgency of mitigating greenhouse gas emissions, recent reports have identified mangroves, saltmarshes and seagrasses as blue carbon habitats for their high rates of CO2 extraction and carbon burial. Here, we develop a framework for rigorously assessing the multiple carbon pathways and transformations in shellfish reefs, and show that shellfish reefs can also contribute to carbon burial on a blue carbon scale. These reef habitats are coupled to carbon-fixing primary producers through intense filtration of seston and subsequent biodeposition of carbon-rich sediments into an accreting reef matrix. Although CO2 release is a byproduct of carbonate shell production, we demonstrate that organic carbon burial can outpace inorganic carbon burial within restored shellfish reefs and that landscape and depth (i.e., aerial exposure) affect whether these reefs operate as net CO2 sources (+) or carbon sinks (-). Although experimental reefs on intertidal sandflats were net sources of CO2 (7.1 +/- 1.2 Mg C ha-1 yr-1; μ +/- 1 SE) resulting from predominantly carbonate burial, shallow subtidal reefs (-1.0 +/- 0.4 Mg C ha-1 yr-1) and saltmarsh-fringing reefs (-1.3 +/- 0.4 Mg C ha-1 yr-1) were net carbon sinks. Reef performance as carbon sinks depended on moderate vertical accretion (0.30-0.82 cm yr-1) dominated by organic-rich material. Notably, carbon pools found within experimental reefs were in line with our measurements from nearby natural reefs (100 to 4000 years old), suggesting our results are relevant over millennial scales. Accordingly, a subset of shellfish reefs can sequester carbon at areal rates on par with acknowledged blue carbon sinks (μ: -1.23 Mg C ha-1 yr-1). Globally, we estimate that the historical mining of oyster reefs could have released >400,000,000 Mg organic C back in the metabolically active estuary, although the role of reef disturbance as a CO2 source or sink ultimately hinges on the fate (dissolution, reburial) of shell material.

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THE EFFECTS OF LOCAL ENVIRONMENTAL CONDITIONS ON THE SPECIFIC GROWTH RATES OF EELGRASS SEEDLINGS AND SEED GERMINATION

Zostera marina L. (Eelgrass), the most common temperate seagrass in the Northern Hemisphere, provides significant habitat for wildlife, improves water quality, and may contribute to shoreline stabilization. Eelgrass populations found in the Delmarva coastal bays frequently experience ecosystem stressors related to land use and climate change. Changes in these lagoon populations over time may be caused by decreased light availability, nutrient enrichment, high temperatures, or differences in recruitment. There is evidence from the southerly coastal bays that seedlings may be particularly important to inter-annual eelgrass meadow dynamics. Ontogenetic growth rates are frequently higher than those for mature ramets, and this difference calls for a new approach to modeling seagrass in locations where sexual reproduction plays a significant role in comparison to clonal growth. Here we present a compilation of literature describing the effects of local environmental conditions on the specific growth rates of eelgrass seedlings and seed germination. This literature review is used to develop a new growth formulation to simulate seedling growth within an existing individual based model.

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WHERE HAS ALL THE SEDIMENT GONE? CHANGES TO NEARSHORE HABITATS FOLLOWING THE DECOMMISSIONING OF TWO DAMS ON THE ELWHA RIVER

Sediment delivery via river transport is a natural geological process that provides an important source of carbon and nutrients to nearshore systems. However, as human activities continue to alter the terrestrial landscape, the timing, amount, and rate of delivery has changed substantially in many watersheds. Increased sediment delivery is of growing concern because it can alter abiotic factors, such as light conditions, as well as negatively impact benthic species and habitats by scouring or burying the seabed. After nearly 100 years, two high-head dams on the Elwha River in Washington State are being deconstructed in the largest dam decommissioning project in United States history. The Elwha Dam was completely removed in March 2012, and the Glines Canyon Dam will be fully removed by 2014. The reservoirs behind the two dams retained approximately 26 million cubic meters of sediment, half of which is estimated to be composed of fine silt and clay. Thus far approximately 20% of reservoir sediment has been mobilized and moved downstream, changing abiotic and biotic conditions in downstream river, estuary, and nearshore habitats. Given the magnitude of sediment discharge from the Elwha River to the nearshore ocean, we have been measuring a number of physical parameters in the coastal ocean near the river mouth, including current speed and direction, water-column turbidity, light availability, and the frequency and duration of sedimentation on the seabed. To document the changes to nearshore habitat and species, we also have been measuring kelp diversity and abundance. Although the magnitude of sediment delivered to the nearshore ocean following the Elwha River dam removals is likely to be greater than from other land-use changes, this study advances our understanding of how the timing and magnitude of sediment delivery affects habitat availability and species persistence and/or recruitment in the nearshore ocean.

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LARGE-SCALE SPATIAL DYNAMICS OF MUSSEL BED COVERAGE IN THE GERMAN AND DUTCH WADDEN SEA

Intertidal mussel beds are important for the functioning and community composition of coastal ecosystems. Modeling spatial dynamics of mussel beds is complicated because suitable habitat is spatially heterogeneously distributed and mussel recruitment is hard to predict. To get insight into the main determinants of dispersion and growth of littoral mussel beds, we analyze spatial distributions and growth patterns in the German and Dutch Wadden Sea. We consider yearly distributions from 36 connected tidal basins between 1999 and 2010 and we use mussel bed distributions for the period 1968 – 1976. We find that in both periods the highest coverage of tidal flats by mussel beds occur in the sheltered basins in the southern Wadden Sea. In contrast to expectation, we do not find evidence that cold winters consistently induced events of synchronous population growth between 1999 and 2010. However, we do find synchronic growth within groups of proximate tidal basins but that synchrony between distant groups is mainly low or negative. We discuss possible mechanisms that may underly the diverging dynamics. Because the boundaries between synchronic groups are located near river mouths and in areas lacking suitable mussel bed habitat we suggest that the metapopulation is under control of larval dispersal conditions. Our study demonstrates the importance of moving from simple habitat suitability models to models that incorporate metapopulation processes to understand spatial dynamics of mussel

beds. The spatio-dynamic structure revealed by this research will be instrumental for that purpose.

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WHOLE ECOSYSTEM ESTIMATES OF PRIMARY PRODUCTION IN A NEW ENGLAND SALT MARSH

Salt marshes are dynamic systems located at the interface of land and ocean. Their long term stability depends on their ability to accrete sediment and to accumulate organic matter to keep their relative position to the sea level. Both processes are dependent on relative elevation and vegetation cover as well as flooding frequency and intensity. Thus, analyzing the response of salt marsh vegetation to tidal influences is important to understand if or how they can adapt to changes in sea level. To study marsh metabolism, we chose the non-intrusive eddy covariance which allows nearly continuous half hourly flux measurements of net ecosystem exchange (NEE). Since spring 2012, we are investigating the marsh-atmosphere exchange of carbon dioxide (CO2) at a Spartina patens high marsh at the Plum Island LTER. Seasonal dynamics of CO2 exchange during summer were controlled by the phenology of S. patens. During the winter months we observed carbon uptake during the day which we attribute to macroalgae productivity. Tidal effects on the carbon exchange are visible especially during monthly spring tides, when both daytime carbon uptake and night time respiration were reduced during flooding. A similar decrease in fluxes has been described at a S. alterniflora marsh at the Virginia Coastal Reserve LTER at high tide events during midday. To partition the net flux into its component fluxes gross primary production and ecosystem respiration, tidal influences have to be incorporated in the NEE model. Measurements of tidal carbon fluxes will help determine how much of the reduction in atmospheric fluxes is due to metabolic changes and how much is due to the exchange of carbon between the marsh and water. Preliminary estimates for seasonal carbon storage range from 185 to 228 g C m-2 (5/1 to 10/31).

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HABITAT CLASSIFICATION CROSSWALK AND MAPPING IN BOSTON HARBOR, MASSACHUSETTS USING CMECS

Massachusetts has been mapping aquatic habitats and resources of its coastal and marine waters by using existing legacy maps and by collecting new acoustic, video, photo, and grab sample data to update species and habitat information. A particular challenge with the mapping effort has been a lack of a consistent classification framework, resulting in maps that may or may not have similar units and that are difficult to compare across different map scales. The Coastal Marine Ecological Classification Standard (CMECS) was accepted as a national standard in the spring of 2012. To explore the applicability of CMECS for state marine mapping needs in Massachusetts, we created a CMECS map in Boston Harbor using existing source maps that were crosswalked to CMECS units. Source maps included wetlands maps, seagrass maps, and NOAA Environmental Sensitivity Index maps. The process entailed identifying the appropriate CMECS unit name for all applicable source units and assessing the confidence in the crosswalk. Then the source maps were combined to create a CMECS habitat map of Boston Harbor. The final mapping products and lessons learned will be presented.

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TRENDS IN SEDIMENT NUTRIENT CYCLING DYNAMICS AND NET ECOSYSTEM METABOLISM OVER TWENTY YEARS IN WAQUOIT BAY, MA

Coastal nitrogen (N) pollution and subsequent eutrophication has become the primary water quality issue for many coastal ecosystems around the world. Although the effects have been extensively studied over the past five decades, many questions remain concerning the impact of eutrophication on crucial biogeochemical processes. In an effort to better understand the relationship between N pollution, metabolism and nutrient cycling dynamics we conducted a study in Waquoit Bay, Massachusetts. The gradient of N loading that exists in Waquoit Bay allowed us to use a space-for-time substitution where we measured the flux of oxygen, ammonium, nitrite, nitrate, and phosphate between the sediments and the overlying water to examine the link between eutrophication and nutrient regeneration. We then compared these current rates (2010-2013) to those measured over the past 20 years in the bay. In addition, we investigated net ecosystem metabolism over the same time period using dissolved oxygen, temperature, salinity, and meteorological data collected every 15 minutes by the National Estuarine Research Reserve Monitoring Program. Although we did not find a linear response between eutrophication and these biogeochemical processes, our results show characteristics of a system in change. The current rate of sediment oxygen consumption measured in our study (1998 $\mu mol\ m^{-2}\ h^{-1}$) was 45% lower than the historic rates and the ammonium release (137 $\mu mol\ m^{-2}\ h^{-1}$) was 30% lower. The current phosphate flux measured in our study was negative (-5.8 $\mu mol\ m^{-2}\ h^{-1}$) while the historic rates were all positive with a mean of 77 $\mu mol\ m^{-2}\ h^{-1}$. Findings from this study indicate that the trajectory of Waquoit Bay nutrient cycling processes over the past twenty years are complex, and may include a fundamental regime change driven by combined impacts of N pollution and global climate change.

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GREEN SEA TURTLE DIETS AND THE IMPACT OF SEA TURTLE GRAZING IN BERMUDIAN SEAGRASS BEDS

Large populations of green sea turtles (Chelonia mydas) use the seagrass meadows of the Bermuda platform as developmental habitat. Juvenile turtles arrive in Bermuda from a neritic early life history at ca. 20 cm long (SCL). The juveniles that survive leave Bermuda as sub-adults when they reach a size of ca. 60-70 cm SCL, tag returns and satellite tracking data show that these sub-adults head to adult habitats in the greater Caribbean and Gulf of Mexico region. Recent declines in the extent of seagrass beds in Bermuda, as well as a perception of increases in populations of sea turtles, led to the hypothesis that overgrazing by sea turtles may be contributing to this decline. Stable isotope composition ($\delta^{13}C$ and $\delta^{15}N$) of skin samples from a large sampling of turtles (n =162) as well as the isotopic composition of potential turtle food items shows that the turtles become increasingly dependent on seagrasses for food as they mature. There was a marked spatial pattern in the $\delta^{15}N$ of the seagrasses on which the turtles feed ($\delta^{15}N$ of seagrasses, -9.3 to 8.6 ‰, n = 380), suggesting that the $\delta^{15}N$ of turtles could be used to assess site fidelity in the older turtles. The smallest turtles showed dependence on a planktonic and animal-based food web. GPS-enabled satellite tags show that the larger sub-adult turtles have very restricted home ranges; they travel only about 1km from an identifiable home refuge to one or more feeding areas over the course of many months, concentrating grazing on seagrasses by individuals to very restricted areas. We show that excluding turtles from declining seagrass meadows halts seagrass decline; heavily grazed seagrass meadow return to baseline values of seagrass leaf width, length, shoot density and productivity within a year of the exclusion of the grazers. Our results indicate that successful conservation of sea turtles in the Caribbean region could have unintended consequences in this important sea turtle developmental habitat.

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ECOLOGICAL EVALUATION FOR ESTUARINE HABITAT RESTORATION OF THE HERRING RIVER USING BIOLOGICAL INDICATORS

The Herring River, Wellfleet and Truro, MA, has over 1000 acres of tidally restricted wetlands slated for restoration beginning in 2015 with the largest estuarine habitat restoration in the Northeast. Reintroduction of tidal flow by means of incremental openings of a rebuilt tidal control structure will eventually restore normal tidal range and salinity, allowing for reestablishment of estuarine processes and improved habitat for estuarine plants and animals. Tidal restoration will be guided by a formal Adaptive Management Plan (AMP) based on predictive models and water quality data. Because of their sensitivity to supply of essential elements in ambient waters, algae and bivalves are used as indicators of water quality. In particular, phytoplankton and macroalgae are integrators of the physical and chemical environment in which they live, and their physiological and chemical responses are transferred up the food web to primary consumers, such as bivalves and other fauna. By incorporating chemical signals from the environment, these organisms serve as bioindicators of ecological integrity. Moreover, algae and bivalves can be used as tracers of particle movement. To understand water quality dynamics in the downstream and upstream reaches by characterizing the pools and assessing movement of nutrients, carbon, and particles within and adjacent to the Herring River, we carried out two bioindicator studies. First, we measured carbon, nitrogen, and sulfur stable isotopes in selected flora and fauna and surface sediments throughout the Herring River to determine nitrogen, carbon, and sulfur sources, and, second, we installed macroalgae and bivalve bioassays to obtain a time and space-integrated view of particle movement. These organisms were successful tracers of flow of nutrients and particles through the system. We observed both import and export of materials following salinity gradients. These studies will be used to inform the AMP and science-based decision making.

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REDUCED LIGHT AVAILABILITY COMPLICATES SUBMERGED AQUATIC VEGETATION RESTORATION IN ESTUARIES THOUGHT TO BE CONTROLLED BY VARIABLE SALINITY

As part of greater Everglades restoration, a multi-year submerged aquatic vegetation (SAV) and water quality monitoring study was conducted in adjacent mangrove sub-estuaries in Florida Bay in order to infer future changes in SAV cover that may result from increased freshwater deliveries. Increasing freshwater to reduce elevated salinities to historical levels is intended to create a more favorable salinity climate for SAV establishment. Despite similar salinity climates, adjacent sub-estuaries exhibited marked differences in light availability, phytoplankton abundance, nutrients, and SAV cover that may complicate this restoration strategy. High light attenuation coefficients (Kd, range = 2.5 - 4.7) and phytoplankton abundances (chl a, range = 13 - 36 μg/L) in the western sub-estuary contrast with much lower levels of light attenuation (Kd, range = 1.8 - 2.3 μg/L) and phytoplankton (chl a, range = 4 - 5 μg/L) in the eastern sub-estuary, leading to lower light availability to the benthos in the western subestuary (mean = 9% surface light) versus that in the eastern sub-estuary (mean = 14% surface light). SAV restoration in the western sub-estuary will require improving light availability to the benthos in addition to salinity reduction. Light availability in these estuaries is controlled by light attenuation, water level and the seasonal interaction between these two. Phytoplankton abundance, turbidity and colored dissolved organic matter were important measured components of light attenuation. The relative importance of these components and their seasonal interactions has varied implications towards SAV restoration that aims to be achieved by increasing freshwater. This study identifies the major controls of light availability and SAV abundance in the region that will guide restoration managers towards SAV re-establishment.

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ENGINEERING WITH NATURE: STRIVING FOR SUSTAINABLE, MULTI-OBJECTIVE COASTAL INFRASTRUCTURE

Engineering With Nature (EWN) is an initiative being undertaken by the U.S. Army Corps of Engineers (USACE) to enable more sustainable delivery of economic, social, and environmental benefits associated with water resources infrastructure. As an approach to developing, engineering, and operating projects, EWN refers to the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits. Demonstration of the EWN approach, and fostering its integration into normal business practices of project design, is intended both to increase project value and to enable greater support by, and involvement with, partners and stakeholders. Although the EWN concept began within the US Army Corps of Engineers, there is a need to reach out to a broader community, integrate the concept more widely with academic research, and look for collaboration opportunities. Part of this outreach effort is the development of demonstration projects. Two examples currently underway include breakwater repair material modifications to increase the epifaunal community production in Cleveland, OH and incorporation of tern nesting habitat into a breakwater repair in Ashtabula, OH. Additionally, recent investigations have identified a number of case studies around the world that can be used to provide models for consideration on projects in their planning stages.

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EFFECT OF HABITAT SHAPE AND SIZE OF RESTORED ESTUARIES ON FISH USE

The sizes of restored estuaries in southern California are limited by available space and project expense. Habitat shape and size can affect fish habitat use; thus, it is important to assess if and how habitat shape plays a role in recruitment and use of restored estuaries, as they can act as fish nurseries. Bolsa Chica Full Tidal Basin (BCFTB) and Huntington Beach Wetlands Complex (HBWC) are discrete restored estuaries in Huntington Beach, CA. HBWC is a 0.77 km^2 creek estuary while BCFTB is 1.48 km^2 open-format full tidal basin. In order to assess how juvenile predator fish use these estuaries on a fine scale, we used acoustic telemetry. Using 95% kernel utilization density distributions (KUD), we found that Grey Smoothounds, *Mustelus californicus* use similar habitat area sizes in both sites. Translocations of *M. californicus* between sites revealed that fish typically return to their marsh of capture with no difference in homing tendency between estuaries. However, more fish used BCFTB interannually. Additionally, catch per unit effort of *M. californicus* in beach seines during summer is higher in BCFTB (approximately 2 sharks m^{-2}) then HBWC (approximately 0.001 sharks m^{-2}). Greater abundance and interannual use in BCFTB may be due to increased habitat size, prey abundance and diversity. Seine data and preliminary stable isotope data indicate potential differences in both prey abundance and diversity. Fish seines captured 31 fish species in BCFTB while only 25 fish species were recorded in HBWC. Preliminary stable isotope data show a δ13C difference in *M. californicus* muscle tissue between sites. Unique carbon signatures may be driven by prey availability or actual δ13C value differences between sites. Because *M. californicus* create home ranges of similar sizes in both sites, competition for resources in a smaller space may lead to prey switching and decreased predator abundance while habitat quality is similar in both sites.

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FINDINGS OF THE SCIENCE AND ENGINEERING SPECIAL TEAM ON SUSTAINABLE RESTORATION OF THE MISSISSIPPI RIVER DELTA

The Science and Engineering Special Team (SEST) was established by three NGOs (National Audubon Society, Environmental Defense Fund, and National Wildlife Federation) to provide objective, independent input on restoration of the Mississippi River Delta. We convened a group of eminent scientists and engineers to address issues related to restoration and sustainable management of the delta. SEST identified 10 questions often raised about the viability of restoration of the Mississippi delta, and critically evaluated these issues. Question topics include sediment availability, the usefulness of diversions, effects of nutrient-rich Mississippi River water, fisheries, navigation and shipping, flood protection, communities, cost, funding, and climate impacts. A comprehensive report answered these questions in the context of the geological, ecological, social, and economic context of the delta. Findings were also summarized in accessible short report and Web formats. These formats allowed for distribution to various community stakeholders, as well as at state and federal agencies meetings, Capitol Hill, and to the press. Results were communicated at a conference for business leaders, community members, university faculty and students, and state and federal agency scientists and decision makers. While the restoration challenges are technically, economically and socially complex, we believe there are solutions and that taking no action will result in a creeping disaster of continued land loss, disruption of major navigation operations, billions in economic losses and the degradation of the most ecologically important deltas in the world. Having documents addressing critical questions authored by leading scientists and engineers in easily comprehensible formats has been very valuable in efforts to move restoration forward.

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ASSESSING THE EFFECTS OF SEA-LEVEL RISE OF PACIFIC COAST TIDAL MARSH ECOSYSTEMS ALONG A LATITUDINAL GRADIENT

Climate change threatens to alter the productivity and rich diversity found in coastal ecosystems that have been identified to be disproportionately affected from changes in sea level, storm frequency, ocean temperature and salinity. The subtidal and intertidal zones of shallow bays, mud flats, and wetlands are a linked continuum, and thus, understanding the complex relationships between them is critical to interpret the effects of climate change stressors. Ecosystem impacts from climate change typically address top-down global to continental scale changes; thus, few are easily interpretable to resource managers or contain a vertical resolution that is useful at the local level for climate change adaptation planning. Our study implements a detailed bottom-up approach to assess vulnerability of tidal

marshes and their dependent wildlife at 15 sites along a Pacific coast latitudinal gradient. Specifically, our objectives are to: 1) Downscale physical processes and climate projections to local scales; 2) Measure morphological and ecological characteristics (e.g. elevation, vegetation, tidal range, hydrology, and geomorphology) across the continuum of tidal marsh, intertidal mud flat, and subtidal shoals; 3) Model wildlife habitats and native species response; and 4) Examine spatial variability along a coastal latitudinal gradient. Data being collected includes bird habitat use, elevation, vegetation, bathymetry, sediment cores, and water level monitoring. Surface elevation tables are also being installed at all sites for long-term monitoring. Research questions, study design, and preliminary data results for elevation and vegetation surveys will be presented for California, Oregon, and Washington study sites.

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EBB AND FLOW: DEFINING RULES OF ENGAGEMENT FOR COLLABORATIVE RESEARCH IN COASTAL WATER QUALITY

Citizen science, public participation in scientific research, cooperative and collaborative research, and many other terms refer to partnerships between traditional scientists and interested stakeholders with the shared goal of creating new information about the world. While there are a number of frameworks characterizing the variety of program structures dotting the citizen science landscape, few have looked within a single case to describe internal factors that influence program structure, and ultimately success and satisfaction with the program. This study focuses on a collaboration between small-scale fishers and scientists in North Carolina with a shared goal of figuring out the causes of recent ecosystem changes. Through a series of workshops and one-on-one meetings, we decided to look at the water quality factors of mercury, PCBs, and pesticides. Through the course of the research, both social and environmental factors structured the interactions between participants and that suggest a framework could be constructed to account for both research goals and participant expectations. Some important factors emerging from this case study include the role of intentional terminology, structured interactions, data sharing, and the role of project facilitators.

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THE EFFECTS OF RECENT SEAGRASS SPECIES CHANGE ON HABITAT STRUCTURE AND FUNCTION

Zostera marina (eelgrass) and Ruppia maritima (widgeongrass) are the two most prevalent seagrass species in the polyhaline Chesapeake Bay. Eelgrass here is growing close to its southern limits along the Atlantic coast of North America and is currently in decline in this region as a result of increasing water temperatures and poor water quality conditions. Annual monitoring along transects has revealed that in some areas, widgeongrass has expanded and replaced eelgrass as it has declined in distribution and abundance. Widgeongrass, an efficient colonizer that is tolerant of a wide range of temperatures, has a less robust morphology than that of eelgrass, the historically dominant seagrass in the Chesapeake Bay. Additionally, widgeongrass peak biomass typically occurs here in late summer compared to eelgrass, which reaches its peak biomass in the early summer.The continued decline of eelgrass and subsequent replacement with widgeongrass may therefore be associated with a change in type and periodicity of important habitat structure and function, including epifaunal composition and abundance, sediment biogeochemical processes and seagrass primary production. We evaluated three sites in the lower Chesapeake Bay that harbor both seagrass species to determine differences between habitats dominated by eelgrass, widgeongrass, or mixed stands, enabling us to estimate how this ongoing alteration of species may affect the ecosystem. This study has implications for other areas in which dominant seagrasses are in decline and replacement by historically non-dominant seagrass species capable of survival in a changing environment is occurring.

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MACROFAUNAL BIOTIC RESPONSES THROUGH THE OMZ OFF SAN DIEGO: A SPACE-FOR-TIME SUBSTITUTION TO EXPLORE SEDIMENT COMMUNITY DIVERSITY AND STRUCTURE WITH EXPANDING OMZS

Where Oxygen Minimum Zones (OMZ) intercept margins the benthic faunas are known to exhibit reductions in macrofaunal abundance, altered composition, decreases in species richness and increases in dominance. As persistent features along upwelling margins, OMZs provide an outstanding natural laboratory to examine ecosystems that have adapted to extreme low oxygen conditions over geological timescales, and could serve as windows to biodiversity and community structure in the future with ocean deoxygenation and acidification. The OMZ off southern California is located between 500 and 1000 m depth. Above the OMZ boundary in the Oxygen Limiting Zone (OLZ), seasonal oxygen concentrations varied up to 50% during 2012, while oxygen concentrations within the OMZ and below the OMZ were stable throughout the year. Cross-margin transect data were collected to investigate macrofaunal biotic responses to persistent oxygen gradients as well as seasonal fluctuations in the OLZ. Other environmental gradients were also considered as contributors to macrofaunal biotic responses including pH, pCO2, temperature, organic matter and grain size. Within the OMZ, diversity and abundance were greatly reduced as compared with communities both above and below the OMZ. Furthermore, feeding modes were restricted to surface- and subsurface-deposit feeders and filter feeders, and predatory lifestyles. This research contributes to a global dataset of macrofaunal patterns across OMZs and diversity indices and densities compare well with macrofaunal responses within the OMZ off northern California and Oregon. Such studies of faunal patterns across OMZs will be discussed as space-for-time substitutions to offer insight into ocean ecosystems of the future, particularly with the shoaling of upper OMZ and OLZ boundaries.

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STANDARDIZED MONITORING AND ADAPTIVE STRATEGIES BASED ON LOCALLY COLLECTED DATA IMPROVE RESTORATION EFFORTS IN CHESAPEAKE BAY

While federal and state agencies are trying to manage the Chesapeake Bay watershed and estuary at regional and multi-state scales, there are volunteer monitoring groups that help manage ecosystems at a local, sub-watershed specific scale. These volunteer monitoring groups are often organized by Riverkeepers® and Waterkeepers® in specific tributaries throughout the Chesapeake Bay watershed. These groups conduct monitoring and outreach at the local level to better understand and improve their tributaries. The Integration & Application Network with the Mid-Atlantic Tributary Assessment Coalition have developed protocols for standardizing monitoring procedures, sampling procedures, and data analysis in tidal streams and estuaries. The tidal protocols provide performance measures and targets for many environmental indicators, and these procedures have been implemented by volunteer monitoring groups. Having standardized monitoring methods available for volunteer monitoring groups is important to inform management decisions. These volunteer monitoring groups not only monitor their watersheds, but they also conduct their own management strategies and use adaptive management based on the data they collect. As local organizations collect more information about their water quality and ecosystem health, they use that information to focus their management actions. This adaptive monitoring and management framework will be elucidated. Large scale as well as small scale restoration is needed to effectively reduce nutrients and sediments to the Bay, as well as to increase awareness and maintain public support and citizen involvement in management actions. Local management, combined with management implemented by state agencies, such as Watershed Implementation Plans and Total Maximum Daily Loads, is vital to restoring the Chesapeake Bay.

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PROVIDING SCIENCE TO SOUTHERN CALIFORNIA NATURAL RESOURCE MANAGERS IN THE FACE OF CLIMATE CHANGE: PRODUCTS OF THE CALIFORNIA LANDSCAPE CONSERVATION COOPERATIVE

The California Landscape Conservation Cooperative is a management-science partnership created to inform and promote integrated science, natural resources management and conservation to address impacts of climate change and other stressors. Our five year goal is to create a growing community of resource managers, scientists, conservation practitioners, and others that are successfully collaborating to promote resilient and adaptable ecosystems across the landscape in the face of environmental change. Products of the CA LCC include vulnerability assessments, online decision support tools and development of climate adaptation strategies. We're meeting partner needs through development of a one-stop shop providing access to these products and more through the California Climate Commons (calcommons.org). The Commons is the go-to website where land managers and technical staff can quickly find climate science, databases, maps, tools and adaptation strategies. It also allows for communication among researchers and the community. Specific to southern California, the Commons contains information on the impacts of sea level rise and fire management strategies for at-risk species. It also contains synthesis articles on how to do a vulnerability assessment, evaluating sea level rise and how to implement climate smart conservation.

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DISTRIBUTIONAL SHIFTS AND SPECIES COMPOSITION DURING SEASONAL HYPOXIA

Hypoxia (dissolved oxygen < 2 mg/L) has been identified as a key threat to the Puget Sound ecosystem, particularly in Hood Canal. Hood Canal is subject to seasonal hypoxia in its southern reaches, and prior work has demonstrated short-term reductions in densities of demersal species in hypoxia-impacted areas. We interpreted these findings as an indication of distributional shifts that reduce mobile organisms' exposure to hypoxic conditions, potentially resulting in secondary ecological effects. We evaluated the nature and extent of these distributional shifts using acoustic telemetry and underwater video monitoring techniques. We deployed an acoustic receiver array in two regions of Hood Canal, a southern highly impacted region and a northern reference region. We assessed individual movement patterns of Dungeness crab and English sole tagged with acoustic transmitters. Within the same regions, we recorded underwater video of the benthos via transects at three depths (10, 20, 30 m) to measure density shifts and species composition. Weekly monitoring of water quality revealed strong gradients in dissolved oxygen over time and space, with the vertical extent of low (<1 mg/L) waters increased markedly at the end of summer in the southern site. While there were no discernible large regional movements to avoid the southern hypoxic area, we did capture significant decrease in southern crab depth through time. The apparent shoaling into shallow waters could potentially increase the crabs' susceptibility to stationary fishing gear. However, we were unable to detect similar shifts in nearshore densities, a possible indication of more patchy distributions of oxygenated refugia. Yet, shallow community composition was significantly different between the two regions; the south was less diverse and primarily composed of invertebrates. This study provides further insight into the complexity of behavioral responses and spatiotemporal heterogeneity associated with seasonal hypoxia.

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MEASURING FOOD WEB CHANGE WITH STABLE ISOTOPES

Many human and natural events can impact aquatic populations and communities, leaving strong imprints as altered food web dynamics. Stable C and N isotopes in especially fish can record these altered trophic dynamics in an integrated way, and a new methodology is presented to extract measures of food web change from fish isotope measurements. Measured C and N fish isotope data are re-scaled as modified z scores to equalize effects of average food inputs, then graphed in (x,y) space to obtain overall food web shapes. Pairs of food webs are compared for shifts in isotope values of individual species, and these shifts are used to assess overall food web similarities. Application of the new methodology shows that 1) competition and habitat can strongly shift niches in local fish food webs, 2) natural background fish communities in different areas can be characterized by significant niche shifts in 10-40% of species, and 3) substantial migration leads to apparent homogenization of food web structures involving fish. The new methodology explained here can be widely used to test for significant time or space changes in fish food web dynamics, but generally will need additional field observations to help interpret the ecological basis and significance of these changes.

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BEHAVIORAL AND PHYSICAL CONTROLS ON OPTIMAL PATCH LENGTHS FOR LARVAL SETTLEMENT ON OYSTER REEFS

Oysters build reefs atop soft sediments, and reef restoration often involves depositing solid material as a substrate for larval settlement and growth. There have been few theoretical efforts to optimize the physical characteristics of a restored reef patch to achieve high recruitment rates. Competent larvae are delivered to a reef patch by larval behavior and by physical processes influenced by habitat characteristics such as substrate roughness, patch length, current speed, and water depth. We used a spatial model, the "hitting-distance" model, to identify habitat characteristics that will jointly maximize both the settlement probability and the density of recruits on an oyster reef (*Crassostrea virginica*). Modeled larval behaviors were based on laboratory observations, and currents and turbulence were based on velocity profiles measured in coastal Virginia over four different substrates: natural oyster reefs, mud, and deposited oyster and whelk shell. Settlement probabilities were higher on larger patches, whereas average settler densities were higher on smaller patches. Larvae settled most successfully and had the smallest optimal patch length when diving in shallow water over rough substrates. The greatest source of settlement variability was water depth, followed by larval behavior, substrate roughness, and tidal current speed. This result suggests that the best way to maximize settlement on restored reefs is to construct patches of an appropriate length for the water depth, whereas substrate type is less important than expected. This mechanistic approach could be combined with a spatially explicit metapopulation model to optimize the arrangement of reef patches in an estuary or region for greater sustainability of restored habitats.

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MECHANISTIC MODELS AS A TRANSFERABLE FRAMEWORK FOR PROJECTING EFFECTS OF HABITAT CHANGE ON PRODUCTION AND DELIVERY OF ECOSYSTEM SERVICES

Drawing a link between habitat change and production and delivery of ecosystem services is a priority in coastal estuarine ecosystems. This link is needed to fully understand how human communities can influence ecosystem sustainability. Mechanistic modeling tools are highly functional for exploring this link as they allow for the synthesis of multiple ecological and behavioral dynamics into a projection of cumulative effects. We developed a spatially-explicit individual-based model intended to explore the link between coastal habitat change and both the production and delivery of recreational fishing to anglers. This model tracks growth, mortality, and movement of individual fish based on temporally and spatially dynamic habitat characteristics and translates the outcome into a projection of annual net fish production. The model also can track angler behavior and distribution as a function of habitat features and allows for a projection of fish-angler interactions and the impact on recreational fishing. This model has been applied in two Gulf of Mexico estuaries (Pascagoula River and Tampa Bay) to address two unique stressors of estuarine habitat (Sea level rise and impacts of landuse change) to examine the influence of mechanistic assumptions on production and delivery outcomes. Findings demonstrate the transferability of the model between ecosystems and stressors. Simulation results also suggest that the link between climatic and anthropogenic stressors related to local decision making, such as landuse change, and fishery health are dependent on behavioral responses, as well as specific habitat alterations. Mechanistic models such as the one use in this study are data intensive, but valuable tools for projecting the impacts of estuarine habitat change because they are easily transferred between systems and are not as dependent on empirically derived relationships, which may also be altered by habitat change.

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SAN FRANCISCO BAY TRANSITION ZONE CONSERVATION AND MANAGEMENT DECISION SUPPORT SYSTEM

A GIS based decision support system (DSS) to identify and prioritize estuarine-terrestrial transitional habitats (transitions) to assist land managers in restoring and protecting San Francisco Bay's (estuary) tidal marsh ecosystem will be presented. Transitions are zones of mixing between adjacent habitats, which historically contained significant floral diversity but have been degraded estuary-wide by human activities. Organismal biologists have credited transitions with providing extreme high tide refuge for secretive marsh fauna, among other critical habitat functions. They have also been identified as part of a landscape that would provide marsh accommodation space during rapid sea level rise (SLR) if their topography is appropriate. The DSS takes a strategic approach towards decision support, by accounting for the landward migration of high marsh and other transitional habitats in response to predicted SLR. Current documents do not adequately describe transitional habitats, quantify the amount needed to aid listed species recovery while allowing for SLR, nor prioritize specific sites for protection and restoration. The DSS combines definitions, GIS models of the distribution of TZH at the landscape level, site specific criteria for ranking sites for restoration or protection, and parcels level maps for prioritizing TZH throughout the estuary. This toolkit will help managers allocate limited resources on site prioritization, alternative/scenario evaluation, and will include considerations for the influence of future climate change and land-use scenarios. Project findings will be made available on the web through an interactive mapping tool.

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TIDAL WETLANDS AS PROTECTIVE GREEN INFRASTRUCTURE: A NEW DECISION SUPPORT MODEL TO GUIDE COMMUNITY INVESTMENT IN GREEN AND GREY INFRASTRUCTURE

Communities are protected from storms and floods by both engineered infrastructure like levees, and natural habitat infrastructure like wetlands. We understand the performance and cost effectiveness of grey infrastructure well, but not green infrastructure. This knowledge gap leads to greater investment in grey at the expense of green. In Puget Sound we evaluated climate change impacts on ecosystem and community vulnerability, including changes in river flow, sea level, sediment and salinity dynamics, and built infrastructure vulnerability. We developed a model, *Coastal Defense*, to quantify the risk reduction provided by tidal wetlands, which attenuate storm wave height and energy, reducing dike erosion, overtopping and flooding. By trapping sediment, wetlands self-maintain and can potentially expand, features that grey infrastructure lacks. Protective functions vary spatially with habitat characteristics such as area, vegetation structure, accretion and subsidence, which all affect community risk and dike maintenance costs. A wave attenuation model can identify key habitats for protecting communities, and opportunities to reduce risk through restoration. Where wetlands are receding with sea level rise, the model can evaluate potential future change in community risk. It can calculate the change in dike height or expanded habitat extent needed to prevent overtopping under alternative scenarios. Strategic restoration of key processes such as sediment and freshwater distribution, can substantially improve habitat trends in the face of sea level rise, and improve community protection. The tool is part of the Coastal Resilience framework at *www.coastalresilience.org*. Restoring self-sustaining habitats reduces long term costs of dike construction and maintenance. With this information, communities can develop better investment plans that reduce the cost of disaster prevention and recovery while restoring ecosystem functions for listed species.

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GUIDING LIGHT

Human activities alter coastal ecosystems on local (e.g., nutrient pollution) and global (e.g., warming temperatures) scales. Teasing these scales of impact apart is a challenging but necessary task if we want to understand how ecosystems respond to anthropogenic impacts. Long-term datasets are essentials tools for such dissections. Over the last three decades unexpected and dramatic ecological changes have occurred in Narragansett Bay, Rhode Island, a temperate well-mixed estuary. In an effort to understand why these changes have occurred we (and others) have examined long-term records in water temperature, nutrients, sediment fluxes, etc. However, none of these have provided a wholly convincing argument for the observed decrease in water column production and subsequent changes in benthic-pelagic coupling. For this reason, we returned to a fundamental requirement of phytoplankton – light. Using the Hubbard Brook continuous light records we found a significant (R^2=0.59, p<0.0001) decline in annual light over the last thirty years. We also found a significant (R^2=0.73, p<0.0001) decline in the mean winter-spring bloom light over this same time period. Importantly, mean annual Narragansett Bay water column chlorophyll *a* and mean annual daily irradiance were significantly correlated. Together these data suggest that the changes in productivity in Narragansett Bay may be driven, at least in part, by large scale regional shifts in climate. These findings have implications for similar observed changes in Waquoit Bay, MA and the Gulf of Maine.

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THE INTERACTIVE EFFECTS OF POLLINATION AND SEED DISPERSAL DISTANCE ON THE DYNAMICS OF SEXUAL RECRUITMENT IN AN ESTABLISHMENT PHASE *ZOSTERA MARINA* MEADOW, SHINNECOCK BAY, NY

Sexual recruitment, the product of successful in/outcrossing and subsequent seed dispersal, has been shown to play an important role in the invasion and regrowth of un-vegetated areas, affording resilience to extant populations through the maintenance of genetic diversity and the preemption of habitable space. The spatial scales at which these processes operate, however, have remained elusive, as pollen transport and seed dispersal are nearly impossible to track in the field, and a lack of methods for non-destructive clone identification has limited genet-level demographic study. This has prevented quantitative estimation of infilling rates and limited our ability to optimize restoration planting-patterns. Here, we combine high-resolution, multi-year seagrass mapping with polymorphic microsatellite analysis to examine the interactive effects of pollination and seed dispersal distance on the dynamics of sexual recruitment in an establishment phase *Zostera marina* meadow. The sub-tidal seagrass landscape (250 x 225 m) was mapped annually to sub-meter resolution for more than a decade using historical aerial photography and georeferenced mosaics generated by balloon-mounted camera. A study site, chosen for its stepwise increase in seagrasses, consisted of a centrally located focal patch (<4m^2), surrounded by a constellation of 134 patches within a 20 meter radius, effectively bounding paternal contributors to seeds fertilized in the central patch. Reproductive shoots were then intensively sampled and mapped throughout the site via gridded quadrat, and recorded using handheld DGPS. Genetic material was recovered from the leaf and a fertilized ovary from the tallest rhipidium and used to examine within- and among-patch pollen transport, as well as to reconstruct the parentage and sequence of dispersal for seed-born patches within the study site.

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THE ASSESSMENT OF NUTRIENT, METAL, AND ORGANIC CONTAMINANT CONCENTRATIONS IN EELGRASS (*ZOSTERA MARINA* L.) IN PUGET SOUND, WA (USA): A PROJECT OVERVIEW

Outfalls that discharge residential, commercial, and industrial wastewater as well as upland stormwater are abundant throughout Puget Sound, WA (USA). However, there are limited data or few regulatory guidelines related to the management of outfalls, and practically no oversight on the impacts outfall infrastructure and discharge have on critical nearshore habitats (e.g., eelgrass and macroalgae). Research has demonstrated seagrasses uptake nutrients, metals and organic contaminants with varied physiological effects, but little is known about the concentration of these substances in eelgrass in the Pacific Northwest and more specifically, in greater Puget Sound. Basic nutrients, nitrogen and phosphorus, are known to be abundant in the Sound, but whether these substances or other contaminants are at levels that cause adverse effects and/or toxicity to eelgrass is unknown. In an effort to meet its land stewardship responsibilities and to support the Puget Sound Partnership's goal to increase eelgrass area by 20% by 2020, the Washington State Department of Natural Resources has identified a need to improve its understanding of key seagrass stressors in greater Puget Sound. The current project conducted a baseline assessment of nutrients, metals, and organic contaminants in eelgrass at 15 sites across Puget Sound. The overview of the project components, sample sites, methods, and preliminary results will be presented.

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2012 COASTAL MASTER PLAN: BUILDING LONG-TERM SUPPORT NETWORKS

The challenges facing coastal communities and ecosystems are becoming increasingly complicated; managing coastal protection and restoration efforts require increased engagement with the public and coastal stakeholders. How can we effectively communicate the issues and potential solutions when ecological and built systems are complex, communities' needs vary, uncertainty abounds, and the public wants immediate results? The Coastal Protection and Restoration Authority (CPRA) created an extensive and effective outreach and engagement strategy for the 2012 Coastal Master Plan. Not simply soliciting public feedback on a finished product, CPRA created a platform for discussion among a range of divergent voices over the two-year plan development process. This process was significantly shaped by the Framework Development Team (a collaboration of representatives from federal, state, and local governments, NGOs, industry, and coastal researchers) and three focus groups (representing fisheries, navigation, and oil-gas) designed to provide industry-specific input. These groups provided significant stakeholder input and ensured the transparency of scientific results and the decision-making process. These stakeholder groups were heavily involved in establishing the plan's objectives and providing overall guidance to the planning process. The long-term dialogue between these groups and the planning team allowed members to build bridges back to their constituents and local communities not directly involved. While not resulting in conciliatory agreement, the conversations among diverse interests were critical to building greater understanding and public acceptance which ultimately led to the plan's unanimous passage by the Louisiana State Legislature. The success of this outreach and engagement strategy has led to the expansion of the number of stakeholder groups and their role in future planning processes and throughout the implementation of the CPRA program.

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LONG TERM VARIABILITY IN ANNUAL PRIMARY PRODUCTION IN THE RHODE RIVER SUBESTUARY OF CHESAPEAKE BAY

A 19-year time series of annual primary production in the eutrophic Rhode River sub-estuary of Chesapeake Bay in Maryland (USA) was analyzed in relation to climatological and ecological factors. Annual production (*PA*) averaged 328 (range 152 to 612) g C m-2 y-1. Interannual variability was statistically significant but there was no significant linear trend or significant non-random variations over the available 19 years. Both the highest and the lowest *PA* were measured at the most upstream station with the greatest influence of freshwater flow from the local watershed. Climatological indices based on North Atlantic Oscillation or flow of the Susquehanna River, the principal freshwater and N source to upper Chesapeake Bay, were not significant predictors of *PA*. A previously published categorization of years based on magnitude of the spring dinoflagellate bloom and timing of nitrate depletion was a significant predictor of *PA*, as was a species composition principal component score that was an indicator of spring blooms of the dinoflagellate *Prorocentrum minimum*. Interannual variability in *PA* was partially dampened by covariance between chlorophyll concentration and the light saturated photosynthetic rate normalized to chlorophyll, *PBmax*, that was evident on bloom-event and interannual time scales.

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BEACH BERMING FOR COASTAL FLOOD DEFENSE IN SOUTHERN CALIFORNIA

Sea levels are expected to rise approximately 1 meter over the next century, significantly increasing the vulnerability of southern California beaches to overtopping and exposing the often highly urbanized backshores to damaging floods. Beach scraping, also known as beach berming or bumping, is the mechanical transfer of sand from the lower beach foreshore to the beach crest. Scraping is widely used to create temporary dunes for coastal flood mitigation, however literature characterizing these anthropogenic dunes is sparse. A decade of aerial LiDAR data is analyzed to determine southern California berm locations and geometries. Berms are present in multiple years at numerous sites from Long Beach to the international border. Berm characteristics such as toe elevation, crest elevation, length and volume are presented. Significant variability in elevations and size was observed, for example mean crest elevations varied between 4 and 8 meters NAVD88 and relative berm volumes ranged from approximately 1% to 10% of the total beach volume above mean sea level. Coastal water levels and wave forcing are estimated using nearby tide gauges and a regional network of wave buoys. Berm efficacy is explored relative to berm characteristics, water levels and empirical wave runup estimates. Finally, a hydrodynamic urban coastal flood model examines the performance of artificial dunes in recent flooding at an urbanized southern California beach.

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MODELING MARSH DEPOSITION IN A BACK-BARRIER ESTUARY: ROLE OF HURRICANE EVENTS IN SEDIMENT-LIMITED SYSTEMS

Coastal marshes are vulnerable to sea-level rise and storm-induced wave erosion. However inundation events may supply sediment to marshes, increasing accretion and elevation relative to sea level. Barnegat Bay, New Jersey, is a shallow, back-barrier estuary with extensive salt marshes. Superstorm Sandy raised water levels and caused inundation increasing the potential for sediment deposition on the marsh. We measured inundation and accretion at three sites spanning the Bay. Changes in surface accretion were variable between sites. The northern marsh experienced 3 mm of erosion at two seaward locations and 5.8 mm of deposition further landward. The barrier island marsh experienced under 1 mm of erosion and the southern site had no change. Overall, measurements suggest the storm redistributed sediments but was not a source of accretion to the marsh. A coupled hydrodynamic, wave, and sediment-transport model of the Bay was implemented, with marsh plain explicitly specified with enhanced roughness. Over the period of the storm, modeled deposition was greatest at marsh edges adjacent to estuarine fringes with the highest stresses, but overall these areas received less than 1 kg/m2 of sediment during the storm. Virtually no deposition occurred more than O(100 m) past the estuarine/marsh interface. These results highlight the mechanism by which sediments are deposited on fringing marshes: episodic storms cause the highest stresses on intertidal flats resuspending sediment, which is advected and deposited on the adjacent marsh. Reduced velocities over the marsh canopy limit the transport to the interior marsh plain. Supply from intertidal flats represents an internal sediment source that is not replenished by the limited external sediment sources. Given the high likelihood of marsh retreat due to wave attack, coastal marshes in sediment-poor systems may accrete due to cannibalization of sediment from intertidal flats, but will constrict due to shoreline erosion.

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BURROWING MACROINVERTEBRATES AND EXCESS NUTRIENTS MAY INCREASE GREENHOUSE GAS FLUXES FROM COASTAL ECOSYSTEMS

Coastal ecosystems, such as salt marshes, are known to be sinks of carbon and thus are important in mitigating climate change. However, with excess inputs of anthropogenic nutrients, salt marshes may become sources of the greenhouse gases (GHGs) rather than sinks. Sediment modifying invertebrates are potential sources of the GHG nitrous oxide (N_2O), as they alter sediment properties, however not much is known about their influences on GHG fluxes within salt marshes, or responses to excess nutrients. To test the hypothesis that invertebrates enhance GHG fluxes from marsh sediments, we examined 3 invertebrates in a mesocosm study: *Uca pugnax, Mytilus edulis* and *Mercenaria mercenaria*. Impacts of *U. pugnax*, or fiddler crab, were tested in mesocosms with sediments receiving 4 treatments: (1) control (background nutrient levels), (2) nutrient addition, (3) crab presence, and (4) crab and nutrient addition. N_2O, carbon dioxide (CO_2), and methane (CH_4) fluxes were measured over 10 hours. The *U. pugnax* mesocosm study showed that N_2O was significantly higher from sediments receiving nitrogen ($F_{3,16}$=8.37, p<0.01), regardless of the presence of crabs. Compared to previous research evaluating gas emissions from invertebrates alone, the N_2O emissions in our mesocosms were an order of magnitude higher, suggesting that sediments are major sources of N_2O. In contrast, CH_4 was significantly higher in treatments with crabs, regardless of the nitrogen treatment ($F_{3,15}$=5.41, p<0.01), indicating potential roles of the invertebrates as sources of that gas (via burrowing or feeding). Other studies in freshwater systems have also shown an increase in CH_4 through burrowing associated invertebrates. Additional experiments are now testing impacts of other dominant sediment modifying invertebrates, including *Mytilus edulis* and *Mercenaria mercenaria*, on GHG fluxes in response to nutrients and warming.

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ADAPTIVE MANAGEMENT OF URBAN WATERSHEDS

Consent decree settlements for violations of the Clean Water Act (1972) increasingly include provisions for redress of combined sewer overflow activity through hybrid approaches that incorporate the best of both gray (e.g., storage tunnels) and green infrastructure (e.g., rain gardens). Adaptive management is an environmental management strategy that uses an iterative process of decision-making to improve environmental management via system monitoring. A central tenet of adaptive management is that management involves a learning process that can help regulated communities achieve environmental quality objectives. We are using an adaptive management approach to guide a green infrastructure retrofit of a neighborhood in the Slavic Village Development Corporation area (Cleveland, Ohio). We are in the process of gathering hydrologic and ecosystem services data and will use this data as a basis for collaboration with area citizens on a plan to use green infrastructure to contain stormflows. Monitoring data provides researchers with feedback on the impact of green infrastructure implementation and suggest where improvements can be made.

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DESIGNING THE BALLONA WETLANDS RESTORATION AS AN URBAN ESTUARY WITH RESILIENCY TO SEA-LEVEL RISE

The Ballona Wetlands Restoration Project is being planned to restore regionally-important estuarine wetland habitats along the constructed Ballona Creek flood control channel in Los Angeles, CA. The proposed restoration will restore tidal wetlands connected to the flood control channel with the goal of creating a self-sustaining wetland system that maintains or improves the existing level of flood protection. Wetland transition and upland habitat ecotones will provide buffers that allow for landward wetland transgression with future sea-level rise while providing a diversity of restored habitats, reducing construction costs, and improving resiliency of the Ballona Wetlands estuary. New perimeter levees will be constructed around the restored wetlands to replace the existing channel levees and accommodate future sea-level rise. Analyses of key considerations within the restoration design will be presented, including tidal hydrodynamics to support estuarine wetlands, flood

performance during fluvial-dominated storm events, and expected long-term geomorphic response of the restored system. The Ballona Wetlands Restoration Project is funded by the CA State Coastal Conservancy (SCC) and is led by a team of agencies including SCC, CA Department of Fish and Wildlife, State Lands Commission, Santa Monica Bay Restoration Commission, Los Angeles County Department of Public Works, and U.S. Army Corps of Engineers.

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SEAGRASS HABITAT SUITABILITY MODELING UNDER VARYING SEA LEVEL RISE SCENARIOS IN THE NORTHERN GULF OF MEXICO

Within the last 150 years, seagrass extent has decreased by over 30% worldwide. Most of these declines are associated with direct and indirect human impacts. The causes of seagrass declines include coastal construction, eutrophication, pollution, overfishing, global climate change and rising sea levels. This is an important conservation concern because seagrass beds are habitat for a rich fauna assemblage, including echinoderms, gastropods, bivalves, pelecypods, annelids, and copepods. They also directly provide food to herbivorous grazers, such as certain fish species, sea urchins, marine turtles, waterfowl and manatees, and they also supply a source of prey for other species. In response to this, detailed conservation and monitoring plans to offset or prevent further human impacts on the seagrass ecosystem have been developed. My proposed research will focus on creating a series of habitat suitability models for seagrasses and how these models will change with different sea level rise scenarios. The project focuses on Northern Gulf of Mexico but will be sufficiently generic that they could apply to other seagrass environments. These models will involve different environmental factors, such as water depth, salinity and turbidity that will impact the distribution of seagrasses within the study area. The habitat suitability models will then be integrated with hydrodynamic model that will provide predictions of future changes in these environmental variables a result of sea level rise. Using these outputs, we can predict areas that will become critical habitats for seagrasses as a result of sea level rise. The results from the seagrass habitat models will then be integrated with hydrodynamic models as well as marsh and oyster models to create useful conservation planning tools. This information will be important to policy makers and natural resource managers to address future management and policy decisions within the study area.

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SEASONAL AND BIOFILM EFFECTS ON SEDIMENT EROSION AND SORTING IN AN INTERTIDAL MUDFLAT IN THE BAY OF FUNDY, CANADA

This study focused on the effects of intertidal mudflat biofilms on sediment erosion and sorting in the Minas Basin of the Bay of Fundy, Canada. From April through November 2012, sediment cores were collected biweekly and eroded using a Gust microcosm. Half of the cores were eroded without undergoing prior treatment, while the other half were treated with bleach prior to erosion to destroy biofilms. Size-specific sediment retention by biofilms was evaluated by comparing the disaggregated inorganic grain size (DIGS) distribution of sediment resuspended from untreated and treated cores, while seasonal variation in natural sediment erodibility was assessed by focusing on the mass eroded from untreated cores only. Results show that biofilms preferentially retained clays and very fine silts (< 10 μm), and that overall sediment erodibility decreased from spring to fall. Results also indicate that abundance of the infaunal amphipod *Corophium volutator* and rainfall increase sediment erodibility.

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IMPLICATION OF HEAVY METALS DYNAMICS IN SEDIMENT PORE-WATER INTERFACE ON MACRO BENTHIC INVERTEBRATE ASSEMBLAGE IN MAKUPA CREEK, MOMBASA

Coastal systems, particularly lagoons, creeks and estuaries worldwide are experiencing increased pollution from anthropogenic inputs including effluents discharged from urban, industrial, agricultural and atmospheric deposition. This has led to degradation of water and sediment quality leading to loss of biological diversity and problems in human health. Heavy metals in sediments cause adverse lethal and sub-lethal effects on the dwelling community. Macro benthic organisms integrate the effects of contaminants over time and are useful indicators of aquatic environment health. The objective of this study was to determine the implication of Fe, Cu, Cd, Zn, Mn and Pb dynamics in pore-water sediment interface and sediments quality on spatial distribution of benthic macro invertebrates in Makupa Creek, Mombasa. The result suggested that sewage effluents from domestic and industrial activities, seepage from solid waste disposal and restricted hydrodynamics have influences on benthic macro-invertebrates and heavy metal distribution in both sediment and pore-water concentrations compared to pristine coastal area. High values of metals partitioning coefficients Kd indicated a strong affinity of the metal with sediment and suggested restricted bioavailability of the metal to benthic invertebrates Analysis of similarity (ANOSIM) revealed no significant difference (ANOSIM Global R: = 0.018, -0.026, -0.196 at p>0.05) and was attributed to common species in study stations. SIMPER analysis revealed limnodriloides barnadi, unidentified nematode, Mesanthula Catenula, Heterodrilus jamiessoni, Olavius geniculatus, Oktedrilus monospermlectus, and unidentified polychaete and Lucifer chacei are the species that contributed highest dissimilarity. Conservation of estuarine and coastal wetlands is important because they are areas rich in biodiversity that play a very important role in energy transfers in aquatic ecosystem.

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CARBON DIOXIDE AND METHANE DYNAMICS WITHIN A TIDAL FRESHWATER CREEK DRAINING LOWLAND ACID SULPHATE SOILS FOLLOWING A FLOOD EVENT

Increased frequency and severity of episodic events (e.g. flooding) as a result of climate change may exert a large influence on carbon fluxes from wetlands. Tidal freshwater wetlands are fast gaining recognition for their important role in carbon cycles and may serve as major carbon sources to estuaries. However there is a lack of research on waterways draining biogeochemically unique landscapes such as acid sulphate soils (ASS), where pH may be consistently lower than four and dissolved oxygen often approaches zero. The aim of this study is to investigate the carbon dioxide (CO_2) and methane (CH_4) dynamics of a modified waterway draining a ASS floodplain through the transition from flooded to dry seasons. We hypothesise that increased hydrological connectivity with the ASS due to large scale construction of drains will impact on creek carbon fluxes. Weekly measurements of CO_2, CH_4, and radon (a natural groundwater tracer) were undertaken at low tide, with physico-chemical parameters and current flow measured throughout the study using in situ loggers. Peak pCO_2 and CH_4 concentrations reached 21330 μatm and 81 μM respectively two weeks after the major flood event. Similarly high floodplain CO_2 and CH_4 values indicated increased methanogenesis and decreased methanotrophy during transport out of the floodplain. Creek CO_2 and CH_4 dynamics followed the same trend up until eight weeks post-flood. A decoupling was then observed as pCO_2 increased from 10912 μatm to 15840 μatm and CH_4 remained below 3 μM. The observed decoupling is likely a result of the increase in dissolved oxygen and associated decrease in pH that occurred during this period. Groundwater discharge appeared to be negligible within the creek having low radon concentrations. The flood event induced large CO_2 and CH_4 emissions from Rocky Mouth creek which seem to be driven by enhanced hydrological connectivity between surface waters and the ASS floodplain.

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INTERACTIONS BETWEEN LITTER AND SOIL NUTRIENTS IN LEAF LITTER DECOMPOSITION OF COASTAL WETLANDS

Altering nutrient concentrations may influence carbon quality and litter decomposition rates in coastal wetlands. Our study sites include a peat dominated salt marsh in RI, a mineral salt marsh in SC, a mineral freshwater marsh in GA, and a freshwater peatland in NC. We had 4 treatments with 3 replicates of nitrogen (N), phosphorus (P), N+P enriched conditions along with unamended control plots in each of these sites. We measured below ground litter decomposition rates of 5 different litter species; Zizaniopsis miliacea, Lyonia lucida, Pontederia cordata, Spartina alterniflora, and Spartina patens by burying one litter bag of each species at 5 cm depth in all treatments in each wetland. The main objectives of our study were to examine a) how nutrient amendments and litter stoichiometry affect short-term litter decomposition rates, and b) if litter decomposition will demonstrate home site advantage. P.cordata and S.alterniflora had low initial C: N ratio suggesting higher quality litter than other species. In unamended plots, decomposition was fastest in S.alterniflora (0.014 g day -1), followed by S.patens (0.0126 g day -1), Z.miliacea (0.0102 g day-1), L.lucida (0.0097 g day-1), and P.cordata (0.0047 g day -1). Decomposition rates were on average 4 fold faster for Z.miliacea and P.cordata, 1.25 fold faster for L.lucida in GA, and 1.25 fold faster for S.alterniflora in NC than in SC. In SC, P increased decomposition by 1.5 fold for P.cordata. The immobilization-mineralization dynamics of N and P in decomposing litter varied by initial litter quality. Decomposing litter with low initial C: N were mineralizing N. Similarly, decomposing litter with low N: P were also mineralizing P over time in decaying litter. We observed home site advantage for decomposition in freshwater sites. Decomposition is a complex process controlled by many different factors including nutrient availability, soil moisture, temperature, and organic matter quality.

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POPULATION-BASED VARIATION IN RESILIENCE TO HYPOSALINITY STRESS IN *HALOPHILA JOHNSONII* EISEMAN

Hyposalinity is the most serious threat to the survival of the threatened seagrass *Halophila johnsonii* Eiseman. Griffin and Durako (2012) determined *H. johnsonii* is tolerant of pulsed hyposalinity down to a salinity of 15; while a gradual reduction in salinity extended its tolerance to a salinity near 5. However, the ability of *H. johnsonii* to recover from near-tolerance exposure to hyposalinity remained unknown. The objective of the present study was to evaluate resilience of *H. johnsonii* to hyposalinity stress. In addition, to examine if there were population-based variations in hyposalinity resilience, *H. johnsonii* was collected from a riverine and marine site. Maximum quantum efficiency of PSII (Fv/Fm) and plant mortality were measured during and after hyposalinity treatments. Mesocosm treatments varied the frequency, duration and amplitude of pulsed or gradual hyposalinity exposure followed by returns to control salinity (25) conditions. Results showed both populations were resilient to short (one week) hyposalinity treatments. However, repeated or prolonged hyposalinity treatments led to population-based variation in *H. johnsonii* health and survival, as marine plants tended to die earlier and in greater numbers than riverine plants (mean overall survival = 33.7 ± 1.5 days for marine plants, 36.2 ± 1.4 days for riverine plants; overall survival = 50% for riverine plants, 28% for marine plants). Furthermore, riverine *H. johnsonii* was more resilient to pulsed hyposalinity, while the marine population was more resilient to gradual changes in salinity. The differential response of marine and riverine populations to hyposalinity supports the suggestion of Griffin and Durako (2012) that there may be ecophenes of *H. johnsonii* that vary in tolerance to hyposalinity. These results may provide a more accurate assessment of the threat hyposalinity poses to populations of *H. johnsonii*.

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NUMERICAL SIMULATION OF A LOWER MISSISSIPPI RIVER SEDIMENT DIVERSION: MORPHODYNAMIC IMPLICATIONS

Sediment diversions are considered and assessed as a strategy to connect the Lower Mississippi River to the surrounding bays and estuaries. In this study, a three-dimensional numerical model is used to evaluate the efficiency of a proposed diversion to capture and convey sediment into the receiving basin and to study its impact on the morphodynamics of the Lower Mississippi River. The diversion is planned to operate during the flood season, when the non-cohesive material (sand) is entrained into the water column and transported as suspended load. Sediment diversions are best placed in the sand path of the river, especially adjacent to lateral sand bars. Those bars are key features of the river morphology in the tidal reach and their size and location can impact and be impacted by the performance of a diversion. The Delft3D model was used to simulate the implementation of the diversion. A mobile-bed model was built to study the reach between River Kilometer (RK) 122 and RK-90 of the main stem. These distances are measured from the river mouth known as the Head of Bird's Foot Delta. The model also includes a proposed outfall channel at RK-98 connecting the River and Barataria Bay. The model was calibrated and validated against field observations of velocities and sediment bed and suspended loads collected from this reach in 2008 - 2011. This research investigates the possible impact of the diversion on the sediment transport and morphology of the river channel within the engineering time scale (~ years to decades). It also studies the design of the outfall channel to ensure efficient delivery of the sediment to the bayside. The analysis includes flow conditions ranging from 17,000 m^3/s (600,000cfs), the approximate threshold for the transport of sand in suspension, up to 34,000 m^3/s (1,200,000cfs), the peak flood flow in that reach of the Lower River.

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DIURNAL VARIATION IN PHOTOCHEMICAL EFFICIENCY OF *THALASSIA TESTUDINUM*, TURTLE GRASS, IN RESPONSE TO SHORT-TERM CHANGES IN LIGHT AVAILABILITY

Seagrasses are considered a keystone community essential to the ecological and economic function of the nearshore ecosystem in Florida Bay, USA. *Thalassia testudinum*, the dominant seagrass in Florida Bay, exhibited a rapid, wide-spread die-off in 1987. The die-off was followed by persistent phytoplankton blooms and a cascade of negative ecological effects. The South Florida Fish Habitat Assessment Program (FHAP-SF) was established to monitor the distribution and abundance of benthic macrophytes, including seagrasses, in Florida Bay and assesses the photosynthetic health of *T. testudinum* using in-situ pulse amplitude modulated (PAM) fluorometry. FHAP-SF sampling occurs in a wide range of weather conditions (i.e. cloudy, sunny, rainy) and each basin is sampled at various times of day; thus diurnal and day-to-day variation must be considered when assessing the PAM parameters over large spatial and temporal scales. Incorporating within shoot variability in PAM fluorescence with leaf growth rates under changing light conditions would provide a more accurate assessment of *T. testudinum* health. However, these measurements are destructive and may not be possible to obtain in situ, therefore a mesocosm study was conducted to compare responses to repeated short-term cycles of shade and full sunlight exposures. Plant responses and PAM data will provide insight into the time-scale of photoacclimation to reductions in irradiance and for onset of, and recovery from, light stress. This information may help identify regions in Florida Bay potentially susceptible to future die offs. With increasing threats to seagrasses, there is a need to establish if nondestructive PAM fluorometry measurements may serve as initial indicators of seagrass population decline, before morphological or density changes are evident.

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EVOLVING THE BED - PHYSICAL AND GEOMORPHIC PROCESSES OF THE SAN FRANCISCO BAY LIVING SHORELINES: NEARSHORE LINKAGES PROJECT

Mitigating shoreline erosion with biologically self-sustaining habitats would lessen the needs for intrusive shoreline protection infrastructure in bays and estuaries. The San Francisco Bay Living Shorelines: Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. Understanding changes to the physical and geomorphic processes in the project area is key to evaluating the impacts to shoreline and mudflat habitats. Waves, currents, and the resultant sediment transport will cause a geomorphic response on the shoreline and bed while the morphology of the bed will affect wave shoaling and sedimentation rates. Waves, currents, sedimentation/erosion, and substrate composition are being investigated at four experimental 32 m x 10 m plots in San Rafael Bay. Turbidity of the water column is also being measured. The plots consist of an oyster reef, an eelgrass planting, a combination of oyster-eelgrass elements, and a control plot of native mudflat. Wave and current monitoring instruments were deployed for 6 weeks in spring 2013 to provide data for a Boussinesq wave model that examines wave attenuation by the reef structures. Sedimentation rates and substrate stability were calculated from high-resolution topographic surveys of the bed. The wave model and sedimentation rates provide guidance for future designs of reefs on how they attenuate waves and impact sediment trapping.

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MONITORED NATURAL RECOVERY AND BENTHIC COMMUNITY RESILIENCE AT A SUBMARINE WOOD WASTE SITE: 10 YEARS AFTER BASELINE

Sawmill Cove is located near Sitka, Alaska and was the receiving point for discharges from the Alaska Pulp Mill from 1959 to 1993. Mill operations resulted in the accumulation of wood solids in some areas up to 20 ft or more in thickness on approximately 100 acres of the seafloor. A remedial investigation and ecological risk assessment of the adjacent seafloor was conducted during 1996-1997. The results of these studies delineated an Area of Concern (AOC) in Sawmill Cove. The Remedial Action Objective for the AOC in Sawmill Cove, as defined in the Record of Decision (ROD), is to reduce ecologically significant adverse effects to populations of bottom-dwelling life from hazardous substances to an acceptable level. The Alaska Department of Environmental Conservation determined this would best be obtained by natural recovery with long-term monitoring every 10 years. The ultimate goal is to have 75 percent of the AOC in an equilibrium community by the year 2040. The long-term monitoring program was designed to measure the degree of natural recovery toward management milestones outlined in the ROD. The baseline survey was carried out in the spring and fall of 2000 using sediment profile imaging, epifaunal video surveys, benthic community analyses, and sediment chemical analyses. Based on the positive results from the baseline monitoring, a cost-effective strategy was recommended for future monitoring

that would save more than 50% of the projected future costs of the program. In 2011, the next round of monitoring based on baseline recommendations was carried out with sediment profile and plan view imaging, sediment chemical analyses, and bioaccumulation testing to address concerns about dioxin contamination. Natural recovery in the benthic ecosystem is occurring faster than originally predicted despite the slow decomposition rate of the wood waste, and bioaccumulation testing showed there were no risks posed by the low concentrations of dioxin detected in the sediment.

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ECOLOGICAL IMPACTS OF *SPARTINA* INVASIONS ON THE PACIFIC COAST OF NORTH AMERICA: AN OVERVIEW

Four species of non-native Spartina (S. alterniflora and hybrids, S. densiflora and hybrids, S. patens, and S. anglica) have invaded intertidal marshes and mudflats on the Pacific Coast of North America. Demonstrated impacts of these invasions occur at the genetic, community, and ecosystem scale. On the genetic scale, a loss of genetic diversity within native S. foliosa due to hybrid swamping and competitive exclusion has been documented in the San Francisco Estuary. On the community level, reductions in species richness and evenness and changes in plant, invertebrate, and bird community composition have been demonstrated in multiple estuaries. On the ecosystem scale, significant shifts have occurred in multiple invaded estuaries in ecosystem processes such as primary productivity and sedimentation. Invasion impacts and recovery trajectories after invasive Spartina removal will be discussed.

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HOW TO PARAMETERIZE ESTUARINE MIXING?

The rate of mixing in an estuary is one of the most important quantities controlling its structure and transport processes. The variation of mixing due to spring-neap modulation of tidal amplitude often results in extreme variation in estuarine structure at fortnightly timescales, and some estuaries exhibit abrupt changes from stratified to well-mixed even within a tidal cycle. Turbulence closure provides a very effective parameterization of mixing in a local context, but the global problem of determining the mixing rate of an estuary based on estuary-scale parameters has not been satisfactorily resolved. Burchard has recently demonstrated that the timescale over which mixing occurs is a key ingredient in the parameterization of estuarine mixing. The inhibitory influence of stratification also needs to be included. A new mixing parameter that includes these quantities in addition to tide-induced stress is defined as follows: $M = C_D U^2/\omega N H^2$, where C_D is the bottom drag coefficient, U is the tidal velocity amplitude, ω is the tidal frequency, N is the buoyancy frequency (as a measure of stratification) and H is depth. When M>1, the estuary tends toward a well mixed state, and M<1 it tends to be permanently stratified. The spring-neap and possibly even tidal variation in stratification may be predicted via the variation in M.

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DENITRIFICATION AND DISSIMILATORY NITRATE REDUCTION TO AMMONIUM IN SEDIMENTS EXPOSED TO OIL FROM THE DEEPWATER HORIZON SPILL

We measured potential rates of total nitrate reduction, denitrification and dissimilatory nitrate reduction to ammonium (DNRA) in sediments from marshes oiled following the Deepwater Horizon oil spill and nearby unoiled marshes. Rates were measured on sediment slurries using standard 15N techniques. Surface sediments were taken in marshes in Southeastern Louisiana from three regions; Terrebonne Bay (TB), western Barataria Bay (WB), and eastern Barataria Bay (EB). In total 13 locations were sampled in July of 2012 which included 6 unoiled locations and 7 oiled locations. At each location 4 samples were taken 5 m apart in a transect beginning at 5 meters from the marsh edge to 20 m from the edge. We did not observe visible oil on the sediment surface at any site. Overall, potential nitrate reduction rates were high, ranging from 300 to over 1,500 nM/ gr wet wt (gww). However, very little of the nitrate reduction could be attributed to denitrification. At some sites denitrification rates were not significantly different from zero and at the remainder denitrification rates ranged from <1 to about 20 nM/gww. Overall denitrification accounted for less than about 5% of the nitrate reduction. Preliminary analysis of the 15N ammonium suggest that nearly all of the remaining nitrate was reduced to ammonium via DNRA. We did not find any significant differences between oiled and unoiled marshes nor did we see consistent differences between locations within the transects. These results contrast with those from marshes in Massachusetts where we found that denitrification rates were higher overall and where denitrification rates were higher than rates of DNRA. The results are somewhat surprising in light of the fact that the abundance of the nirS gene for denitrification at these sites was relatively high compared to data from northern salt marshes.

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SEVEN FAT YEARS AND SEVEN LEAN YEARS: VARIATIONS IN RECRUITMENT OF JUVENILE *LIMULUS POLYPHEMUS* IN A MASSACHUSETTS SALT MARSH OVER A THIRTY-FIVE YEAR SPAN

Little Sippewissett salt marsh on Buzzards Bay in Falmouth, Massachusetts, is in most years an ideal nursery ground for juvenile horseshoe crabs from their first instar at 5 mm to subadults of 120 mm prosomal width. Adult Limulus lay their eggs on sandbars just downstream of the marsh proper, a situation that allows an abundance of hatched larvae to be swept into the sandy flats of the marsh at high tide. However, the pipeline to the production of subadult stages can be affected by environmental threats, resulting in bottlenecks and, in extreme cases, complete destruction that requires rebuilding of the pipeline from its beginning. This report contains graphs of instar stages by season in milestone years starting in 1984, a timeline, and representative photographs. Threats to the population include: predation by raccoons, egrets, crabs (green, blue, and fiddler); fluke infestation; weather events (hurricanes, and other storms in summer, ice cover in winter), and man-made detriments (oil spills and excessive nitrogen). The population lost significant nursery ground area in 1991 due to the Halloween storm (Perfect Storm), and was completely wiped out by a cold winter in 1994. The rebounding population has remained healthy and all stages appear to be thriving, with two- and three- year-olds particularly strong. The set of larvae will not be known until late July, which will be in time to report at the November meeting.

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IMPACT OF OFFSHORE CONDITIONS ON ESTUARINE RESIDUAL CIRCULATION AND NUTRIENT AND OXYGEN SUPPLY

Connectivity between the coastal ocean and estuaries as well as between adjacent estuaries along a coastline can impact both the physics as well as the biology of these systems. Realistic hindcast ROMS simulations coupled with a bio-geochemical model of the Pacific Northwest including the Salish Sea and Columbia River estuaries and the coastal ocean off of the Washington and Oregon coasts show these connections. Model dye releases, numerical experiments, and a detailed examination of the total exchange flow at multiple cross-sections in the Salish Sea allow us to quantify the influence of offshore conditions on the estuarine exchange. Strong seasonal and interannual variability are observed. In particular, we find that downwelling winds can create reverse estuarine circulation, however the presence of the Columbia River plume offshore strengthens the reverse estuarine circulation by up to two times within the Strait of Juan de Fuca. Additionally we examine the impact these reversals have on nutrient and oxygen supply to the estuary. High nitrate, low oxygen water is supplied at depth during upwelling. During downwelling, reversed circulation and Columbia River intrusions bring high oxygen, low nitrate water into the estuary at the surface.

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DO THEY STAY OR DO THEY GO? A STUDY OF SITE FIDELITY AMONG *MUGIL CEPHALUS* AND *MUGIL CUREMA* ALONG THE MID-SOUTH ATLANTIC BIGHT

Diversity studies among three barrier islands, Hunting Island, SC, Cockspur Island, GA, Tybee Island, GA, showed that two fish species, *Mugil cephalus* and *Mugil curema*, are consistently present in coastal waters. The current investigation looks to determine whether these ecologically and economically important fish species stay in one area or migrate in and out of a region during different stages of their development (juvenile or adult). Current literature for the genera suggests seasonal site fidelity for both species, but not much current published data has been studied on either *Mugil* species. Using monofilament and cotton mesh bag seines, a fish measuring board, and T-Bar anchor tags, fish were caught using a quarter haul technique, measured with the fish board to nearest cm, identified, tagged and released. Tagging occurred subcutaneously behind the first dorsal fin on *Mugil spp.* at least 7.0 cm. Fishes were tagged at a range of sizes in hopes to tag a wide variety of age classes to determine their site fidelity. To date 3 Striped Mullet and 54 White Mullet have been tagged on Tybee; 1 Striped Mullet and 9 White Mullet have been tagged on Cockspur; and 26 Striped Mullet and 39 White Mullet have been tagged on Hunting. Only one tagged fish has been recaptured to date, it was recaptured on Hunting Island, SC.

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EFFECTS OF NO-FISHING MARINE PROTECTED AREA IMPLEMENTATION ON MACROALGA-HERBIVORE TROPHIC INTERACTIONS

Documenting shifts in trophic group interactions following the implementation of marine protected areas is key to understanding marine protected area (MPA) success, or otherwise. Benthic habitat structuring is heavily reliant on processes that occur higher up the food web. Given this, establishing how MPA implementation affects the oft forgotten lower end of the trophic cascade can assist in determining MPA effectiveness on multiple spatial scales. Here we present the results of a multi-disciplinary approach to deciphering some of these trophic interactions. Firstly, a global systematic review and meta-analysis revealed a relationship between primary producer and herbivore population trajectories according to habitat type, following the implementation of an MPA. These results support the top-down food web structuring hypothesis in protected area networks, except for herbivorous fish on coral reefs, where populations increased in response to removal of fishing pressure. Field studies were then conducted inside and outside no-fishing MPAs in the subtropical Moreton Bay Marine Park (MBMP), Queensland, Australia. Benthic video survey, baited remote underwater video and traditional underwater visual census techniques were used in field studies to test the ecological application of different trophic structuring hypotheses and distribution theories, such as the ideal free distribution. This series of studies highlights the importance of regional scale management in the conservation of benthic marine environments and demands the selection of MPAs to be based not only on benthic habitat quality, but also on the processes that assist in the recovery of marine ecosystems in the aftermath of fishing.

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EFFECT OF THREE ECOLOGICAL GROUP CLASSIFICATION SCHEMES ON PERFORMANCE OF THE AZTI MARINE BIOTIC INDEX IN US COASTAL WATERS

The AZTI Marine Biotic Index (AMBI) is an established index for the assessment of benthic habitat quality that requires relatively little calibration data and is free of any geographic specificity compared to most other benthic indices. That being said, the AMBI has not performed as well in the coastal waters of the United States as it has in those European waters for which it was originally developed. This problem may be due to the traditional use of pan-global tolerance values or Ecological Group (EG) within the index. In the present study we tested three alternative approaches for establishing EG values created by expert benthic ecologists from around the US: 1) regional; 2) national; or 3) a hybrid of national and standard AMBI values. The AMBI was calculated with each of these EG schemes and applied to data sets from three different geographies from around the US. Performance of each scheme was evaluated by the accurate diagnosis of condition in pre-defined good/bad sites, concordance and correlation with existing local benthic indices, and insensitivity to natural environmental gradients. The AMBI performed best when using EG assignments developed by US experts, supplemented with standard EG values for taxa which the US experts did not have sufficient expertise to assign. The new US AMBI performed as well or better than locally derived indices for differentiating good and bad site condition. However, when considering the whole spectrum of condition, it tended to compress ratings away from the extremes and rate more sites as moderate. Additionally, there was a bias towards poorer condition when evaluating sites from lower salinity (<15 psu) waters.

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TOWARD UNDERSTANDING THE ROLES OF MANGROVE AND SEAGRASS PARTICULATE MATTER AS A NITROGEN SOURCE IN TROPICAL COASTAL ECOSYSTEMS

The location of tropical mangrove forests and seagrass beds along coastlines and shallow water areas enables them both to receive and process particulate organic matter (POM), as well as inorganic and organic nitrogen in dissolved forms. Little is known about the potential importance of POM transfer between mangrove forests and seagrass beds as a nutrient source. Transportation experiments in Koh Yao Yai Island (Southern Thailand) showed mangrove leaves were the dominant POM source exported to seagrass beds, but there was little difference between the POM forms (seagrass/mangrove leaves) exported to the coastal ocean. Seagrass leaves and mangrove leaves show differential degradation pattern. The slow degradation of mangrove leaves could potentially contribute greatly to the nitrogen demand of seagrass beds. In contrast, the rapid degradation of seagrass may form a more important nitrogen source for dissolved organic nitrogen into the water column, even within the seagrass beds. However, because of the rapid timescales involved in the degradation processes and resultant nitrogen release, seagrass leaves may not be an important nitrogen source unless local hydrodynamics promote their quick transfer to other ecosystems. These results contribute to the understanding of nitrogen processes and transport pathways within tropical coastal seascapes.

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QUANTIFYING SPATIAL VARIABILITY OF MICROBENTHIC ALGAE USING OPTICAL REFLECTANCE MEASUREMENTS

Tidal mudflats are inhabited by communities of microbenthic algae that contribute to the productivity and biogeochemistry of coastal wetlands and estuaries. These algae migrate vertically, surfacing at low tide, and a fraction of the algae slough off the mud surfaces and drain into tidal streams. These algae can represent a significant proportion of water column algal communities and provide trophic support for grazing invertebrates (mud snails) and filter feeders (oysters). Variation in microbenthic algal pigment features were evident in 2006 AISA Eagle aerial imagery acquired at Sapelo Island, Georgia. In the summers of 2012 and 2013, hyperspectral scans were taken at close range over different areas of Georgia coastal mudflats using an Ocean Optics USB 2000 spectroradiometer. Chlorophyll *a* and cyanobacteria phycocyanin signals were clearly discernable. Sediment samples were collected from the upper 5 mm and analyzed for chlorophyll and accessory pigment concentrations. We found substantial spatial variability in algal densities within and between sites. We have produced provisional predictive algorithms for estimating the microbenthic algal densities on exposed mudflats using selective wavelengths, and are working to parameterize these algorithms for use with high spatial and spectral resolution airborne spectroscopy.

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PHYSIOLOGICAL IMPACTS OF SHORT-TIME VARIABLE ACIDIFICATION STRESS ON PACIFIC OYSTER (*CRASSOSTREA GIGAS*) LARVAE- A PROXY MEASUREMENT AND A CONCEPTUAL FRAMEWORK

Experimental work has shown generally negative impacts of ocean acidification on calcifying organisms. Early life history stages of several coastal bivalve species, such as the Pacific oyster (*Crassostrea gigas*), are particularly sensitive to elevated pCO_2, low *p*H, and low aragonite saturation state. High-resolution carbonate chemistry data collected in coastal areas have documented highly dynamic changes over a range of spatial and temporal scales. Bivalve larvae are exposed to these temporal and spatial variations throughout their several week larval period. Differential sensitivities to acidification stress among larval stages and associated persistent carryover effects have been observed. Thus, to realistically quantify physiological stress it is important to understand the impacts of exposure history

to changing acidification conditions. However, the effects of variable carbonate chemistry exposure in larvae are poorly understood as, to date, most studies exploring acidification impacts are based on constant carbonate chemistry treatments. We present preliminary results of *C. gigas* larval responses to variable rates of increasing and decreasing pCO_2 at three different developmental stages: D-hinge, veliger, and competent to settle. We measured RNA:DNA ratios as a proxy for acidification stress on hourly timescales. Finally, we introduce a novel conceptual framework developed to quantify different components of physiological stress due to variable conditions during the larval period. Our conceptual model integrates an instantaneous stress metric due to variable carbonate chemistry and is based on environmental thresholds. This framework bears similarities to degree-day models by integrating physiological responses over time, but also accounts for stress in rapidly changing conditions and aims to assess the potential for physiological recovery.

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THE EFFECT OF *ZOSTERA MARINA* CANOPY COVER ON PHYSICAL CONDITIONS AND ABUNDANCE OF EPIFAUNAL MACRO-INVERTEBRATES IN A SEAGRASS MEADOW IN NORTHERN BAJA CALIFORNIA, MEXICO, USING A MANIPULATIVE FIELD EXPERIMENT

Several mechanisms have been proposed to explain why seagrass presence favors a more diverse community, including that seagrasses provide a predation refuge, a food source, and a reduction of physical stress. However, to date it is unclear if the change in community structure that follows a reduction in seagrass cover at small spatial scales in the field is due to the actual lack of seagrass, or whether the change is simply due to the change in physical conditions, such as the increase in light or temperature, that occurs when seagrass is removed. Physical data (current velocity, temperature and light) and scallop abundance (Argopecten circularis) collected in a shallow meadow of Zostera marina where seagrass cover was manipulated to high, medium and very low coverage will be presented. The structural complexity of seagrass on the physical conditions within the canopy as well as on the abundance of epifaunal macro-invertebrates will be discussed in light of the rapid decline in seagrass cover worldwide in the past decades, and the importance of marine meadows as a nursery habitat for several economically and ecologically important species.

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EVALUATING EROSION PROTECTION AND FISH HABITAT USE OF STABILIZED AND NATURAL SHORELINES IN A HURRICANE-IMPACTED ESTUARY

Climate change is adversely affecting coastal ecosystems. Higher shoreline erosion rates caused by increased frequency and intensity of storms may prevent coastal habitats from keeping up with rising sea level, forcing habitats to transgress landward. While artificial shoreline stabilization is often implemented to reduce erosion, bulkheads placed landward of intertidal habitat can prevent transgression, resulting in habitat loss. Alternatively, marsh sills (intertidal low-crested breakwaters) may allow for transgression and sustainment of supported ecosystem services. To determine the erosion protection capability of different types of shoreline stabilization structures during a storm event, we measured marsh surface elevation pre- and post-Hurricane Irene at sill and natural (unarmored) sites and surveyed shoreline damage post-Irene. In the central Outer Banks, NC, where the strongest sustained winds occurred, Irene damaged 76% of bulkheads surveyed, while no damage to shorelines with marsh sills was observed. Hurricane Irene had no effect on surface elevations of marsh sill or natural sites located within 25 km of where Irene made landfall. To determine how armoring affects fish utilization of intertidal habitat, we sampled fish communities in marsh, seagrass, and mudflat adjacent to armored (bulkhead or sill) and natural shorelines. Marshes with sills contained significantly higher fish abundance, biomass, and diversity than natural marshes. Mudflat adjacent to bulkheads supported significantly lower fish abundance and biomass than habitat adjacent to sills. These results suggest that marsh restoration, in conjunction with the use of marsh sills, may protect shorelines from erosion and also sustain fish habitat better than bulkheads.

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STAKEHOLDER PERCEPTIONS AND PRIORITIES: MODELING AND DATA IN WATERSHED PLANNING IN DOUBLE BAYOU, A RURAL WATERSHED OF AN URBAN ESTUARY

The Double Bayou watershed is situated in the eastern portion of the Lower Galveston Bay watershed (the Trinity-San Jacinto Estuary) on the Upper Texas Gulf Coast. During a watershed characterization conducted in Fall of 2010 and Spring of 2011, stakeholders in the Double Bayou watershed were identified, including community leaders, elected officials, landowners, nonprofit organizations, and representatives of relevant local, state, and federal agencies. Stakeholders were introduced to background information and data results; to identify key issues, and solicit stakeholder input. The watershed characterization process addressed the water quality problems of reduced dissolved oxygen (DO) and elevated bacteria in the bayous, as well as laid the groundwork for implementation of strategies to restore water quality through the development of a Watershed Protection Plan for Double Bayou. During the Watershed Protection Plan process, it is imperative to gain the stakeholders acceptance of and participation in the loading calculation and source models necessary to fully characterize the pollutants in the watershed. Conflicts arose between different sets of stakeholders (landowners, agricultural extensions agents and conservation districts) as well as stakeholders and the scientific community. This discussion will focus on challenges in presenting the data and model results to a diverse group of stakeholders in a coastal watershed.

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CHANGES IN NUTRIENT FORM AND STOICHIOMETRY AND THEIR ROLE IN SHAPING THE PHYTOPLANKTON COMMUNITY IN SAN FRANCISCO ESTUARY

One of the common paradigms of the San Francisco Estuary (SFE) is that it has been uniquely resilient to nutrient effects due to high rates of benthic grazing. As a consequence, classic symptoms of eutrophication- hypoxia and harmful algal blooms- were considered to be rare in this system. In recent decades, however, there have been more outbreaks of harmful algae as well as a shift in dominant primary producers. Beginning several decades ago, diatom abundance decreased sharply, while and cyanobacteria and flagellate abundances have increased. Evidence from nutrient uptake studies, combined with increasing knowledge of the molecular regulation of nutrient metabolism by phytoplankton group have led to new hypotheses regarding the importance of nutrient form and ratio in shaping phytoplankton community composition. Here, results from recent physiological experiments and nutrient enrichment bioassays from SFE are used to confirm that previously held notions that nutrients confer importance in shaping community composition only when concentrations limit phytoplankton growth need to be reconsidered. Changes in nutrient form and stoichiometry at all concentrations levels, from limitation to excess, fundamentally alter physiology, in turn affecting food quality for grazers. The dynamics of such nutrient regulation by phytoplankton within SFE are comparable to those of many other estuaries similarly impacted worldwide.

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OCEAN'S TWIN ASSAULT: THE IMPORTANCE OF CONCURRENTLY EVALUATING THE EFFECTS OF HYPOXIA AND ACIDIFICATION ON MARINE ORGANISMS

Low oxygen zones in coastal and open ocean ecosystems have expanded in recent decades, a trend that will accelerate with climatic warming. There is growing recognition that low oxygen regions of the ocean are also acidified, a condition that will intensify with rising levels of atmospheric CO2. Presently, however, the concurrent effects of low oxygen and acidification on marine organisms are largely unknown as most prior studies of marine hypoxia have not considered pH levels. Here we present experiments assessing the consequences of hypoxic and acidified water for early life stage bivalves (bay scallops, Argopecten irradians, and hard clams, Mercenaria mercenaria) and larval fish (Menidia menidia, M. berylina) marine organisms of significant economic and ecological value

and sensitive to climate change. In larval scallops, experimental and naturally-occurring acidification reduced survivorship, low oxygen inhibited growth and metamorphosis, and the two stressors combined produced additively negative outcomes. In early life stage clams, however, hypoxic waters led to increased mortality, while acidified waters elicited reduced growth. Later stage clams were resistant to hypoxia or acidification individually but experienced significantly reduced growth rates when exposed to both conditions simultaneously. In larval fish, hypoxia and acidification had a synergistically negative effect on survivial. Collectively, our findings demonstrate that the consequences of low oxygen and acidification for early life stage bivalves and fish are more severe than would be predicted by either individual stressor and thus must be considered together when assessing how ocean organisms respond to these conditions both today and under future climate change scenarios.

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HOW WELL DO FRESHWATER TIDAL ESTUARIES SERVE AS REARING HABITAT? A CASE STUDY OF OTOLITH GROWTH IN JUVENILE ESTUARINE REARING AND MIGRATORY CHINOOK SALMON (*ONCORHYNCHUS TSHAWYTSCHA*)

Estuaries provide juvenile fish species with foraging habitat, and refuge from predation or other stressful environmental conditions. These estuarine rearing fish species cross ecosystem boundaries, effecting nutrient movement and reinforcing the connectivity between aquatic and marine habitats. Here we evaluate the condition of estuarine rearing habitat by examining the growth of a migratory and estuarine rearing fish species. I will be discussing preliminary results from a year-round, estuary-wide study examining the otolith growth of juvenile Chinook salmon (Oncorhynchus tshawytscha) in 18 freshwater tidal habitats throughout the Columbia River estuary. We used otolith microstructure to asses both the local and evolutionary forces effecting growth throughout near shore habitats in the upper ~144km of the estuary. This landscape scale study strives to provide a better understanding of the spatial and temporal habitat requirements for juvenile estuarine rearing salmon, and assist in targeted and sustainable solutions for species persistence.

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EVALUATING THE SUCCESS OF A RESTORED MARSH DESIGN USING ASSESSMENTS OF SEDIMENT DYNAMICS AND VEGETATION

In coastal Alabama, natural and artificial wave-attenuating structures are used to restore reef habitats and protect vulnerable shorelines. While natural reef designs catalyze a number of biological systems upon implementation, evidence suggests that these structures are less adept at mitigating coastal erosion in high energy systems. At Little Bay, a fully restored marshland site, we monitor sediment and marsh vegetation to illustrate how larger complexes of wave-attenuations devices (WADs) are better suited to mitigate erosion. Surveys conducted using real-time kinematic GPS (RTK GPS) show marked differences in elevation within the first 60 meters shoreward of the WAD complexes. Overall, there is a net positive accretion of sediments, signifying high sediment retention throughout the site. Density and expansion of transplanted marsh vegetation have increased as well, indicating more shoreline stability. These results suggest that accretion of sediment and slow expansion of emergent marsh vegetation can be attributed to the use of wave-attenuating devices that heavily armor the restored shoreline. While additional research will be needed to expound upon the sediment transport mechanisms and vegetation dynamics, this data may help guide future restorations where shoreline protection is paramount.

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SUBSURFACE EDDIES WITH LOW-OXYGEN CONTENT IN THE NORTHERN BAJA CALIFORNIA UPWELLING REGION

Subsurface eddies with low-oxygen content might be common feature in eastern boundary currents. Subsurface eddies observations off the continental slope of Baja California are presented. During July 2004 a 21-day hydrographic survey in the southern part of the California Current was carried out as part of the ongoing IMECOCAL program. A subsurface anticyclone eddy with the same water mass characteristics as the California Undercurrent was discovered off northern Baja California. The eddy core showed a quasi-circular diameter of 70 km and a maximum swirl velocity of 30 cm/s. The water mass of the eddy core was distinguished from the adjacent waters by its 11 °C temperature, 34.5 salinity and 1.4 ml/l oxygen content. On the other hand, during October 2009 a high-resolution survey off northern Baja California was carried out to investigate subsurface eddies. At the beginning of the survey, the winds were predominantly upwelling-favorable, and days later a relaxation event occurred. The wind patterns included a positive wind stress curl along the coast, which was stronger during the upwelling-favorable period. Analysis of the shipboard ADCP data revealed an anticyclone eddy situated off the Punta Baja continental slope. The eddy was below of the mixed layer. Its water mass was characterized by 11 °C temperature, 34.2 salinity and 1 ml/l dissolved oxygen. It had diameter of 64 km, maximum swirl velocity of 22 cm/s, Rossby number of 0.14, and rotational period of 11 days. The water mass of the eddy core was identical to the water mass of the California Undercurrent. The generation of eddies is probably associated to an interaction of the California Undercurrent with topography through a baroclinic instability. Because mesoscale eddies move toward the southwest in the northeastern Pacific Ocean, subsurface eddies are a transport mechanism of relatively low-oxygen waters from the slope to the adjacent sea in northern Baja California.

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ASSESSING NO NET LOSS AND BUILDING THE CAPACITY OF LOCAL GOVERNMENTS IN AN URBAN ESTUARY – A GALVESTON BAY CASE STUDY

Palustrine wetlands and the ecosystem services they provide are being lost at an increasing rate in the Lower Galveston Bay watershed on the Upper Texas Gulf Coast. Losses are largely due to the growing human population and associated development patterns in a region which is home to more than 6 million people and the 4th largest city in the country. The Clean Water Act Section 404 wetland permitting and mitigation process is a key way in which wetland function and ecosystem services are maintained in the Houston-Galveston region. However, without examining the long-term status of permit and mitigation activities, there is no way of knowing whether the No Net Loss policy is effective in this Gulf Coast estuary. The federal wetland permitting process as it is implemented on the Upper Texas Gulf Coast is separate and disconnected from numerous construction permitting ordinances and procedures implemented by local and county governments. The trend of palustrine wetland loss in the Lower Galveston Bay watershed will likely continue unless the entities responsible for regulating local residential and commercial development activity and land use have the capacity to consider wetland habitats as well as wetland permit and mitigation activities in local permitting decisions. Presenters will examine the long-term status of wetland permit and mitigation activities in the Lower Galveston Bay watershed and will discuss bridging the gap between development and land use permitting decisions of local governments, the federal wetland permitting process, and regional habitat conservation goals.

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A COMPARATIVE LIFE-CYCLE ASSESSMENT OF SUBSTRATE MATERIAL USED IN OYSTER REEF RESTORATION

In spite of the continued decline of oyster reefs, there have been global efforts to improve their condition through reef restoration and management. In Texas, recent projects involve the deployment of hard material onto natural beds to provide suitable substrate for oyster larvae to attach and grow. Literature on the ecological effects of oyster restoration focuses on the impacts of constructed reefs on primary productivity, nutrient dynamics, water quality, and benthic communities. However, there can be an extensive range of environmental effects associated with the life cycle (extraction, manufacturing, transfer, and deployment) of natural or alternative substrates turned into oyster beds. Some of these effects include: resource consumption, greenhouse gas emission, and land use. The object of this study was to conduct a Life Cycle Assessment (LCA) to analyze environmental effects associated with five different substrates used in an oyster reef pilot restoration project in Rockport, Texas. Analyzed substrates included recycled concrete, recycled porcelain, recycled oyster shells, river rock, and limestone. Two analyses were conducted using GaBi LCA software. Analysis 1 studied a cradle-to-grave LCA of new materials (limestone and river rock). The cradle-to-grave LCA quantified the environmental effects associated with the extraction, manufacturing, packaging, transportation, and deployment of limestone and river rock. Analysis 2 quantified the greenhouse gas emission impacts associated with the end-of-life cycle of recycled materials (concrete, porcelain, and oyster shells). For analysis 2, three scenarios were considered. The first scenario (termed scenario A) assumed disposal of substrates into the bay, scenario B assumed disposal of substrates into the Corpus Christi landfill, and scenario C assumed that the materials were processed to make them available for raw materials.

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COEXISTING ALTERNATIVE STABLE STATES AT A TROPICAL COASTAL LAGOON (LAGUNA LARGA, CUBA) UNDER EUTROPHICATION AND HYDROMORPHOLOGICAL STRESSES

Laguna Larga is a choked coastal lagoon in Cuba, where intense tourist development started in 1991. Impacts have included multiple hydromorphological alterations due to hotels construction and operation (>1600 rooms) around and on the lagoon, plus high and variable nutrient loads from sewage discharge, surface runoff and groundwater pumping, which are causing the eutrophication of the lagoon. Monitoring of Laguna Larga has proceeded since 2007, including temperature, salinity, oxygen, nutrients, total P and total N. Primary producer communities have also been studied, for their composition, productivity and N isotopic signature ($\delta^{15}N$). Water and salt balances show the lagoon has 3 different sections in terms of water exchange and residence time. The inner section has much longer residence times (0.1–0.7 years), while the outer, more communicated, exchanges its volume in 1–9 days. In contrast, nutrient loads are much higher (17.3 mol P d^{-1}, 267.5 mol N d^{-1}) in the outer section than in the inner one (2.7 mol P d^{-1}, 148.3 mol N d^{-1}). In spite of this, trophic indexes indicate that eutrophication decreases from the inner end to the outlet of the lagoon. Primary producers community states found in the lagoon also follow a pattern associated to water exchange more than to nutrient loads. A phytoplankton community dominates nowadays the inner section, while several stable community states coexist in the middle and outer sections of Laguna Larga, which include epiphytic micro and macroalgae as well as opportunistic ephemeral macroalgae and seagrass meadows. *Ruppia maritima* is present throughout the lagoon, but while it forms meadows in the outer section, it is scarce and dispersed in the central and inner sections. Net primary production was lower in the inner section (0.71 g C m^{-2} d^{-1}) than in the outer section (4.32 g C m^{-2} d^{-1}). $\delta^{15}N$ values indicate sewage discharge influence in some of the apparently unaltered seagrass communities offshore the lagoon

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THE ADAPTING TO RISING TIDES (ART): COLLABORATIVE SEA LEVEL RISE ADAPTATION PLANNING ON THE SAN FRANCISCO BAY SHORELINE

The Adapting to Rising Tides (ART) is a unique, multi-sector/multi-jurisdiction adaptation planning project aimed at increasing the Bay Area's resilience to sea level rise and storm events. Led by the San Francisco Bay Conservation and Development Commission (BCDC) and the National Oceanic and Atmospheric Administration Coastal Services Center (CSC), the project engaged local, regional, state and federal agencies and organizations in a collaborative effort to consider how best to improve shoreline resilience across six cities, one unincorporated community, a number of special districts, and a portion of a county. The project evaluated existing conditions and stressors, conducted a vulnerability and risk assessment, and developed adaptation responses for natural and built assets in four sectors: community land use, transportation, utilities and shorelines. In addition, the project developed, tested and refined adaptation planning methods and tools, and produced guidance on how best to evaluate, communicate and address complex issues associated with sea level rise and other climate change impacts. The project also investigated the issue of adaptation planning scales, and is currently testing the tools and methods developed at a local (e.g. county) scale at a smaller neighborhood scale. The neighborhood scale planning effort will also help to reveal where relationships between land uses, facilities and services may cause secondary vulnerabilities, and where there are synergies and constraints among adaptation options. Lastly, the ART project placed special attention on integrating social equity, economy, environment and governance into all steps of the adaptation planning process. These efforts resulted in a framework for carrying these "four frames" through the planning process, and in special issue papers on social equity and governance in adaptation planning.

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USING A NOVEL AUTOMATED IDENTIFICATION TECHNIQUE TO ENHANCE OUR UNDERSTANDING OF BIVALVE LARVAE IN A TURBID ESTUARINE ENVIRONMENT

Our understanding of the distribution, abundance, and transport of bivalve larvae is limited due to their small size, the similarity between species, and lack of a low-cost automated approach for identification. The objective of this research is to investigate how physical-biological interactions influence the vertical swimming behavior of Crassostrea virginica (eastern oyster) larvae in the Choptank River, a tributary of Chesapeake Bay. We present a novel automated image analysis system that rapidly enumerates, measures, and identifies bivalve larvae, based on the ShellBi method. This method relies on the unique patterns emitted by the shells of bivalve larvae under polarized light. Using an automated stage and camera system for image acquisition coupled with the ShellBi pattern recognition software, bivalve larvae are imaged, measured, and classified to species categories. We present tests that we conducted to ensure its reliability. Example application of the automated system to identify bivalve larvae in 270 samples will be described along with discussion of successes and challenges of this automated approach.

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BIOLOGICAL CONTROL OF *ARUNDO DONAX*, AN INVASIVE WATER-USING WEED IN THE BI-NATIONAL RIO GRANDE BASIN

Arundo donax, also known as giant reed, or carrizo cane, is an exotic and invasive weed of riparian habitats in the southwestern U.S. including the bi-national Rio Grande Basin. Giant reed dominates these habitats which leads to: loss of biodiversity; stream bank erosion; reduced visibility along the international border for law enforcement agencies; increased risk of cattle fever tick invasion into the U.S.; and reduced conservation of water resources in an arid region where these resources are critical to the environment, agriculture and urban users. Biological control using insects from the native range of giant reed in Europe may be the most sustainable option for long-term management of this widespread weed . Two biological control agents have been released and established on the Rio Grande in Texas and Mexico; a stem-galling wasp, Tetramesa romana; and Rhizaspidiotis donacis, a scale insect that feeds side shoots and below ground rhizomes (roots). A third insect, a leaf miner, Lasioptera donacis is under evaluation. The impact of T. romana and R. donacis on A. donax is underway using tools which estimate changes in above ground biomass; water use, plant stress and climate interactions of the agents and A. donax genotypes. Methods for mass rearing and aerial distribution of the agents have been developed to accelerate the impacts of the biological control effort. Our primary goal is to reduce the dominance of giant reed which should allow for passive revegetation of the riparian zone in the Rio Grande Basin of Texas and northern Mexico.

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INTERACTING ECOSYSTEM ENGINEERS: BIOIRRIGATING LUGWORMS HAMPER SEAGRASS GROWTH BY CAUSING EUTROPHICATION AND AGGRAVATING SULFIDE STRESS

When two ecosystem engineers share the same natural environment, the outcome of their interaction is unclear if the engineering effect may have both potential positive and negative effects at the same time. It may be expected that the outcome depends on local

environmental settings. We studied this by analyzing the co-occurrence of the sediment stabilizing seagrass Zostera noltii and the bioturbating and sediment-destabilizing lugworm Arenicola marina. Although these species can have a strong negative interaction, they may also successfully co-occur. We questioned if the negative sediment destabilization effect by Arenicola marina on Zostera noltii might be counteracted by positive biogeochemical effects of the pumping and sediment reworking by Arenicola marina in sulfide-rich sediments. Therefore, we tested the separate and interacting effects of Arenicola presence and high sulfide concentrations (induced by organic matter addition) on seagrass biomass in a full-factorial lab experiment. Contrasting to our expectations, we found accumulative negative effects of stressors, Arenicola presence and increased sulfide levels, on seagrass biomass at the end of the experiment. Arenicola bioirrigation affected the seagrass biogeochemically, by pumping nutrients, mainly NH4 and PO4, from the porewater to the surface water. The latter promoted epiphyte growth on seagrass leaves. Moreover, pumping by Arenicola increased porewater total sulfur concentrations, which resulted in extremely high sulfide concentrations in the treatment with both stressors. We conclude that not only the well-known physical disturbance, but also altered (pore)water biogeochemistry and fluxes to the overlying water column by bioirrigation, can negatively affect seagrass growth and survival.

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ASSESSING THE STATE OF MARINE ECOSYSTEMS: A HOLISTIC APPROACH

Human pressure on marine ecosystems has led to concern for their species and habitats and the sustainability of the services they provide to humans. Approaches to management include conservation of organisms or habitats (for their own sake) and aiming for maximum sustainable yield of a resource (e.g. fisheries). Both neglect the trophic and spatial connections between ecosystem components. There are two concerns: ecosystem state can change markedly under pressure, with consequential loss of services; pressures and their effects are typically managed separately. Recognizing this, the 'Ecosystem Approach' requires integrated management of marine systems, and so there is a need for holistic indicators of condition that are grounded in a theory of ecosystem functioning. Ecosystems have been interpreted as: sets of species populations, responding to their abiotic environment; a system comprising the sum of its parts with biotic interactions and co-evolution; an integrated system with emergent properties (e.g. resilience) that cannot be localized in particular ecosystem components. Systems theory provides a means for describing ecosystem state independent of interpretation. Change in state can be tracked using the ecosystem's co-ordinates on orthogonal axes of state variables. Ideally, healthy systems would be identified as occupying particular co-ordinates in state space. However, there is currently inadequate theory to do this, although variability about long-term trends could be used to recognize a decrease in system resilience. We illustrate the approach using long-term data sets from the (European) North Sea. One example uses simulated primary production, copepod abundance, and sea-bird reproductive success. Euclidian distance from an arbitrary reference condition was used to determine trend and variability in state. The second example is based on the functional diversity of phytoplankters and a frequency method to quantify change from a reference envelope.

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GENETIC ANALYSIS OF SUBMERGED AQUATIC VEGETATION USING ISSR AND RAPD ANALYSIS

In low salinity estuaries, submerged aquatic vegetation (SAV) form a habitat that serves as a nursery for fishes and provides food for water fowl and because of its importance the state of North Carolina seeks to enhance and protect this habitat for coastal fisheries. We examined the genetic diversity of SAV (*Ruppia maritima* (widgeon grass), *Vallisneria americana* (wild celery) and *Potamogeton perfoliatus* (redhead grass)) in Currituck and Albemarle Sounds, NC to investigate how to maintain genetic diversity during restoration efforts. We used randomly amplified polymorphic DNA (RAPD) and inter-sequence short repeating (ISSR) primers to generate unique profiles for each species. The highest percentages of polymorphic loci (PPL) found for *R. maritima*, *V. americana* and *P. perfoliatus* were 77.27, 80.00 and 92.59 respectively. An analysis of molecular variance (AMOVA) showed that the highest level of diversity revealed was by a single ISSR primer at 24% for *P. perfoliatus* across three sample sites. *V. americana* showed less diversity among sites at 17% while *R. maritima* exhibited a mean level of diversity of 10%. Nei's genetic distance for all species was observed between 0.1 and 0.2 using ISSR primers and between 0.032 and 0.095 with RAPD primers. This indicates a minimal level of genetic diversity for these three species across the region's SAV habitats. Principle coordinate analysis (PCA) illustrated the differences among the sites for each species based on the genetic distances. These results suggest that there are low amounts of genetic diversity among these sites for these three species.

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DEVELOPMENT OF A SUPERIMPOSED HYDRAULIC NETWORK AT A HYPER-TIDAL RESTORATION SITE

Tidal wetlands provide many beneficial ecosystems services including valuable fish habitat, protection against storm surge and sea level rise, and carbon sequestration. Human activities have led to degradation and loss of these habitats, particularly in macro-tidal estuaries where the practice of land reclamation through dyking is prevalent. In the Bay of Fundy, where tidal ranges can exceed 16 m, the loss of salt marsh has been estimated at 80-85% since European settlement making the restoration of these habitats a priority in the region. The progress of a salt marsh restoration project carried out in the summer of 2009 was assessed in light of lessons learned at another site breached in 2005 with a similar history. The research focused on the development of a hydraulic network at the restoration site, which was found to be occurring at a rate comparable to other studies. The incorporation of drainage ditches, relict creeks, and surficial rills throughout the site into a hybrid/superimposed network allowed rapid dewatering and efficient movement of water through the site in the initial year of restoration. By the second year many of these channels were no longer detectable through aerial photography or site visits. The creation of a single dyke breach at the restoration site, as opposed to multiple breaches at the 2005 project, has had significant impacts on how the system functions with regards to tidal inundation and circulation, creek erosion, and species diversity. A lack of sedimentation in some areas, a delay in the removal or detrital matter, and the high probability of prolonged velocity pulses in the primary channel leading to erosion and slumping indicate that more breaches are preferable. The long term impact of this decision may not be apparent for many years, making continued monitoring of the site critical.

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METHODOLOGY TO ASSESS ESSENTIAL FISH HABITAT IN SAN DIEGO BAY

Under the authority of the Magnuson-Steven Fishery Conservation and Management Act (MSA) and the regulation of the National Marine Fisheries Service (NMFS) in conjunction with regional fishery management councils, many coastal areas are federally designated as essential fish habitat (EFH), "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." EFH has been designated in all coastal Navy areas of responsibility (Hawaii, Southwest, Northwest, Atlantic, Northeast, and Southeast). In accordance with the MSA, any activity funded, permitted, or carried out by the Navy or other federal agencies that may have potential impacts to EFH must include at least an informal consultation with NMFS. The entirety of San Diego Bay has been designated as EFH. However, San Diego Bay has a long-history of dredging, pollution, and other anthropogenic activities, which have led to some waters in San Diego Bay being federally designated as "impaired water bodies" under the authority of the Clean Water Act. San Diego Bay, a highly urbanized estuary, provides a port to three Naval installations (Naval Base Point Loma, Naval Base Coronado, Naval Base San Diego). It provides an excellent test case for demonstrating methodologies for assessing the value of EFH, as there are historical fisheries datasets and an active fish ecology program in the Bay. Utilizing biotelemetry, hydroacoustic surveys, and GIS, we are examining seasonal patterns in habitat usage, detecting potential habitat preferences for the association of three fish species (Leopard shark (Triakis semifasciata), California halibut (Paralichthys californicus), and Barred sand bass (Paralabrax nebulifer)) with various habitats types in San Diego Bay. In addition, environmental data will be used in conjunction with fisheries and biotelemetry data within a boosted regression tree model that will predict high quality habitat areas throughout San Diego Bay.

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THE VIEW FROM OCEAN BEACH: INTERAGENCY COASTAL ADAPTION PLANNING IN A CONSTRAINED URBAN SETTING VIA THE OCEAN BEACH, SAN FRANCISCO MASTER PLAN

The Ocean Beach Master Plan was developed by the San Francisco Planning + Urban Research Association (SPUR) and a team of consultants, working with the land owners and

stakeholders. The draft plan was finalized in 2012 (http://www.spur.org/ocean-beach). The Master Plan is a vision of the west shore of San Francisco through 2100, and covers 3.5 miles of National Park beach, major transportation and sewer infrastructure, and extensive residential and commercial development. Consideration of coastal processes and a public process informed the tough decisions needed to balance infrastructure protection with beach recreation and ecology. To inform the Master Plan, four scenarios comprised of both projected climate change and adaptation approaches were developed and modeled through the year 2100. The primary climate change parameter considered was accelerated sea level rise, and the interim guidance provided by the State of California was used, consisting of 16" (0.3 meters) of rise by 2050 and 55" (1.4 meters) by 2100. The effects of sea level rise on shore positions, beach widths and coastal flooding were analyzed for the years 2030, 2050 and 2100. Four thematic adaptation approaches were developed, each intended to foster public assessments of different priorities (habitat, infrastructure protection, infrastructure modification, and recreation). After a series of meetings with the public and several committees (steering, technical and working), a fifth scenario was tested and was found to be generally acceptable. The plan includes both specific actions as well as guiding principles for subsequent implementation, along with an anticipated "update" by 2050 to refine additional adaptation for the second half of the century. The Ocean Beach Master Plan is presently being refined through technical studies and additional stakeholder processes.

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A NOVEL TECHNIQUE FOR DETERMINING THE IMPACT OF OCEAN ACIDIFICATION ON THE FEEDING PHYSIOLOGY OF BIVALVE LARVAE

Uptake of atmospheric CO2 by oceans, resulting in ocean acidification (OA), is predicted to significantly change the carbonate chemistry of many marine ecosystems in this century. Calcifying marine bivalves are commercially and ecologically valuable and their larvae have been reported to be the most sensitive life stage to OA effects. Research on the physiological effects of OA on bivalve larvae has largely focused on shell deposition, growth and survivorship. Potential effects on larval feeding physiology have not been addressed, despite it being widely recognized as an important determinant of growth and fitness at later life stages. OA studies with adult bivalves have shown that higher ingested algal rations can compensate for increased metabolic demands associated with OA stress. We present findings on the impacts of OA on the feeding physiology of marine bivalve larvae using a novel approach, based on feeding larvae mixtures of differently colored fluorescent beads and measuring rates of changes in colored bead ratios in the gut. We have explored how OA may impact ingestion rates, gut filling, and gut passage time. Furthermore, by using a suite of chemically manipulated water treatments, we have been able to separate the effects of dissolved CO2 (pCO2) and aragonite saturation state (Ωarg) on larval feeding physiology. Bead ingestion rate was positively correlated with Ωarg for Blue mussel (Mytilus galloprovincialis) and Pacific oyster (Crassostrea gigas) larvae, while pCO2 had no effect on their feeding activity. Although gut filling rates were positively correlated with Ωarg, gut passage times were unaffected by both Ωarg and pCO2. Our data suggest that larval feeding behavior will be impacted by predicted future reductions in Ωarg, with likely adverse consequential effects on larval growth and survival.

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USEPA'S NATIONAL COASTAL CONDITION ASSESSMENT: STATUS, RESULTS AND NEXT STEPS

The National Coastal Condition Assessment (NCA), a US Environmental Protection Agency monitoring program, assesses the condition of the nation's estuaries and coastal waters. USEPA partners with states, tribes, federal agencies and other entities to sample estuarine and near-shore coastal waters across the US and in the Great Lakes. In 2010, the NCA became the National Coastal Condition Assessment (NCCA), a part of the Office of Water's National Aquatic Resource Surveys (NARS) program. Similar to the NCA program, NCCA employs a probabilistic survey design and standardized indicators to determine the ecological condition of estuaries at national and regional scales. Individual indices to assess sediment, fish tissue, benthic, and water quality condition are applied to determine the extent of US estuaries and coastal waters in good, fair or poor condition. The results of the 2010 sampling effort will be presented, as well as plans for the next round of sampling in 2015.

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DEVELOPMENT OF SEAGRASS DISTRIBUTION MODEL TO ASSESS WADING BIRD RESOURCE SELECTION WITHIN THE GREAT WHITE HERON NATIONAL WILDLIFE REFUGE, FLORIDA KEYS

Most seagrass mapping efforts combine all species present in an area into one vegetation cover class. Whereas this is efficient for assessing large areas, it assumes functional redundancy among seagrass species. However, some studies showed that each seagrass species supports different fish and invertebrate communities thus different prey availability for higher trophic levels. To address species-specific spatial patterns, we quantified the percent cover of turtle grass (Thalassia testudinum), shoal grass (Halodule wrightii) and manatee grass (Syringodium filiforme) along 12 km of shallow (< 2 m deep) intertidal seagrass flats between Upper Harbor Key and Howe Key within the Great White Heron National Wildlife Refuge, Florida Keys. From July 2012- May 2013, 325 plots spaced 50 or 100 meters apart along transects that were between 200 and 700 meters in length. At each point, percent cover of each seagrass species was quantified via snorkeler using a 1 m2 quadrat and georeferenced with a handheld GPS unit held over the center of the plot. The resulting map of seagrass distributions will be used in conjunction with mapped locations of Great White Herons (Ardea herodias) and Little Blue Herons (Egretta caerulea) to inform foraging habitat resource selection functions for both wading bird species. Preliminary assessment of data suggested that Little Blue Herons were more likely to be found in habitats that included high cover of shoal grass. Our work is a critical next step in the understanding of higher trophic level interactions in these seagrass ecosystems.

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DOUBLE DIP "TIPPING POINTS": RECOVERY FROM EUTROPHICATION IN TAMPA BAY, FLORIDA

In Tampa Bay, Florida, eutrophic conditions (as indicated by chlorophyll a concentrations, water clarity and seagrass extent) continue to be ameliorated due to voluntary and regulatory nitrogen load reduction actions by public and private entities. In the late 1970s, eutrophic conditions (phytoplankton and macroalgal blooms, seagrass losses and anoxia) were evident throughout the bay. Implementation of regulatory requirements reduced total nitrogen loading to the bay by approximately 90% from WWTPs by 1981, and dramatic decreases in chlorophyll a concentrations and increased water clarity soon followed. Seagrass expansion was evident within several years following the sharp reduction in nitrogen loadings. Between 1982 and 1996, seagrass extent increased by 2,131 ha (average 152 ha/yr). In 1998, very heavy winter rains associated with a strong El Nino led to increased TN loads, reduced water clarity, increased chlorophyll a concentrations and a loss of 840 ha of seagrass. Since then, voluntary efforts by 40+ public and private sector Tampa Bay Nitrogen Management Consortium members have resulted in an additional 500 tons TN load reduction (offsetting TN loads from increasing population in the watershed). Water quality in the bay is now consistently meeting state and federal regulatory limits. Between 1999 and 2012, water clarity and chlorophyll a concentration targets have been met in most years, and seagrass has increased by nearly 4000 ha (305 ha/yr), an annual average rate twice as high as in 1982-1996. There is an indication that Tampa Bay may have experienced two 'tipping points' from its past eutrophic state in 1980, each resulting in different response rates in water quality and seagrass recovery.

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HOW DO WE SUPPORT HEALTHY, FUNCTIONAL ESTUARINE WETLANDS IN SAN FRANCISCO BAY FOR THE NEXT HUNDRED YEARS?

The San Francisco Baylands Ecosystem Habitat Goals report, produced in 1999, created a sea change in restoring and enhancing wetlands around the Bay's edge. Scientific guidance from the Goals report had contributed to the restoration of 7,000 acres of tidal marsh to date, with 30,000 more acres acquired and permitted for restoration in the coming decades. However, the 1999 report did not include climate change impacts or adaptation strategies, with the idea that climate change would be addressed in the next iteration of the adaptive management cycle. A technical update to the Baylands Goals is underway that addresses how to maintain the ecological integrity of the San Francisco Bay wetlands and their biological communities over the next hundred years. The Update synthesizes current scientific knowledge about impacts from climate change and other drivers of change on the Baylands and recommends actions to ameliorate those impacts. Specifically, the Update

considers how different future scenarios (of sea-level rise and sediment availability) would influence the evolution of tidal marshes, shoreline migration, the transition zone between Baylands and terrestrial areas, wildlife populations, and carbon accounting. Over 100 experts in science, restoration, resource management, and regulation from across the region are developing the content of the Update, with oversight from a steering committee of environmental management and regulatory agencies and an independent science review panel of national experts. Near-term (until 2030) and long-term (until 2100) visions for the entire Bay and its subregions (Suisun Bay; North, Central and South Bays) will be presented. Detailed strategies for how to achieve these visions through particular actions for each subregion will also be discussed. At the time of abstract submittal, these visions and strategies had been drafted and were under revision, but were not yet approved for dissemination in the abstract.

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SEA LEVEL RISE PLANNING IN LOS ANGELES: CONFRONTING A RISING SEA IN A COASTAL METROPOLITAN REGION

In 2012, University of Southern California Sea Grant, along with 14 local, state and federal partners, released the results of a California statewide climate change adaptation needs assessment survey. The goal was to understand coastal communities' research and information needs and the barriers they face in planning for climate change, specifically sea level rise. We will discuss some findings of this survey, and illustrate these through a case study on sea level rise planning in the City of Los Angeles, as well as current efforts underway to develop a multisectoral SLR planning process for the Los Angeles Greater Metropolitan Region. USC Sea Grant, in partnership with the City of LA, developed AdaptLA, a science-based and stakeholder-supported SLR adaptation planning process and vulnerability study. AdaptLA provides a methodology to help the City of LA identify the vulnerabilities of its assets, resources and residents. This effort includes assessments of the physical, social, economic and ecological vulnerabilities and identifies a set of potential adaptation actions and guidance for evaluating adaptation measures. Regional stakeholders engaged in this project expressed a strong interest in and need for expanding this effort to include coastal subregions, such as neighboring cities and unincorporated areas of LA County outside of the discontiguous political boundaries of the City of LA, but deeply interdependent and interconnected. The LA region recognizes that addressing climate change issues in a regional context builds opportunities for cooperative and mutually beneficial planning while taking advantage of economies of scale in training, information acquisition and scientific guidance. We will provide an overview of AdaptLA, discuss regional collaboration in LA, and discuss successes and challenges encountered thus far.

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A FUTURE FOR BARRIER ISLANDS: IMPACTS OF CLIMATE CHANGE ON KEY SPECIES AND HABITATS ON ASSATEAGUE ISLAND

Barrier islands provide critical protection to mainland shores by absorbing the energy of coastal storms and sheltering the highly productive marshlands and estuaries on the bay side. We present the results from a review on the impacts of climate change on Assateague Island, a relatively undeveloped barrier island in Maryland that is part of the U.S. National Park System. Not only are barrier islands at the forefront of climate impacts from sea level rise and storms, but also they serve as a mesocosm to understand the implications of climate change. The changing climate system, which will include higher air and water temperatures, rising sea levels, and increasing storm intensity and perhaps frequency will serve as a template for understanding island change. On Assateague Island in particular, the expectation is that the island will be driven to a more homogenous state by further stressing fragile ecosystems, particularly those intolerant of salt and intense storms. Saltwater stress, drought, and storm disturbances will result in loss of forest, inland wetland, saltmarsh, and dune habitats, as well as declines in horse, amphibian, SAV, marsh nesting birds, and other species. Sea level rise and interactions with storms will result in an Assateague Island that will be subject to more frequent and severe overwash, breach and inlet formation, and erosion. Further evaluation of climate impacts should closely examine the likely response of vulnerable species, foodwebs, and ecosystem functions, however National Park staff are taking the first, necessary steps to adapt to the changes the island is already experiencing, enhancing management strategies for enhancing island wide resiliency by protecting and restoring these species and habitats.

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MODELING NITRATE LOADINGS FROM AGRICULTURAL WATERSHEDS IN PRINCE EDWARD ISLAND, CANADA

Anoxic events occur in estuaries in many parts of the world and such events reduce the diversity of coastal species and, in some cases, lead to ecosystem collapse. The province of Prince Edward Island (PEI) in Atlantic Canada has experienced declining conditions in many estuaries for more than a decade. Large amounts of sea lettuce or microscopic algae blooms occur regularly in at least 28 estuaries. Nitrates derived from intensive agricultural activities are thought to be the major driving force for the degrading conditions. The Northumberland Strait – Environmental Monitoring Partnership (NorSt-EMP) project is currently monitoring coastal areas of PEI and quantifying the land-based stressors including nitrates, phosphates and sediments. The overarching goal is to develop decision-making tools to assess the cumulative impact of human activities. Among these tools, a spatially lumped nitrate model is being designed to estimate annual nitrate loads and concentrations coming from PEI watersheds. Nitrate attenuation based on the width of riparian buffer zones, as well as the transport delay due to groundwater residence time, are both accounted for in the model. A two-reservoir flow module is used to differentiate rapid flow from delayed flow. The modeling approach assigns these two flow paths a nitrate concentration reflecting the land use composition of the watershed. To analyze the uncertainty of the results each key model parameter is assigned a probability distribution function. The model is then run several times with different sets of parameters chosen by a Latin hypercube sampling method. Twelve watersheds with long-term monitoring data have been used for model calibration (R2=0.92), while 122 different watersheds were used for model verification (R2=0.82). The results for the time period of 1996 to 2012 indicate a good agreement with observed average annual concentrations especially for agricultural watersheds having catchment areas larger than 6 km2.

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RESOLVING COMPETING MANAGEMENT GOALS: OPTIMAL STRATEGIES FOR ERADICATION OF INVASIVE HYBRID *SPARTINA* AND RECOVERY OF ENDANGERED CALIFORNIA CLAPPER RAILS IN SAN FRANCISCO BAY, CA

In coastal ecosystems, conflicts among competing management goals are becoming increasingly common. One conflict likely to become more common in the future is that between eradication of invasive species and recovery of endangered species. We present results from one of the very few documented examples of this conflict, the eradication of hybrid cordgrass (Spartina alterniflora x foliosa) and the recovery of the federally endangered California clapper rail CLRA (Rallus longirosrtis obsoletus) in San Francisco Bay, CA. We couple long-term field data with simulation models to develop optimal strategies for balancing Spartina eradication program and CLRA recovery. The bay-wide eradication of invasive hybrid cordgrass has been 'derailed' due to declines in CLRA populations coincident with eradication. CLRA now use invasive hybrid Spartina as nesting habitat in the absence of native S. foliosa, so USFWS dictates that a portion of the invaded region remains untreated to maintain CLRA populations. A key to CLRA recovery following eradication of hybrid Spartina is rapid replanting of the native Spartina to replace breeding habitat. The results of our model show that extensive manual planting of native Spartina is not the optimal strategy under typical levels of natural regrowth of native Spartina. The optimal strategy under most scenarios would be to invest heavily and early in natural recovery of native Spartina and slow the rate of eradication of the invader. Consequently, the most efficient strategy is one that is less intense, but occurs over a longer time frame. This strategy stands in sharp contrast to the optimal eradication strategy in the absence of CLRA, which suggests eradicating all invasive Spartina as fast as possible. Our conclusions and approach apply broadly to similar management conflicts that are likely to be more common in the future, where a high priority invader provides habitat or trophic support for an endangered species.

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SHIFTING SHORES: PATTERNS OF TRANSFORMATION AND RESILIENCE IN THE BAY'S SHORELINE

San Francisco Bay has experienced some of the most dramatic transformations of an estuary worldwide and stands to change dramatically again in the coming decades. There has been substantial concern about marsh erosion in response to diminished regional sediment supply and accelerated sea level rise. At the same time, extensive tidal marshland restoration is taking place. However there has been no protocol or dataset for assessing and evaluating trends in marsh shoreline position. In this project we (1) developed a methodology and conceptual model for mapping and comparing marsh shoreline positions over time; (2) mapped marsh margin positions at three time steps: circa 1856, 1993, and 2009/2010; (3) analyzed the spatial patterns of shoreline erosion/progradation during these intervals; and (4) assessed the implications for management strategies to protect and restore the marsh

shoreline. Our initial findings indicate that trajectories of shoreline erosion are highly heterogeneous, controlled by the local hydrogeomorphic setting. Contrary to expectations, we are finding that much of the San Pablo Bay marsh margin has been expanding rather than eroding over the past two decades. This assessment identifies areas of relative shoreline resilience and sensitivity, suggesting areas of high priority for marsh conservation as well as areas of greater concern. These geomorphic trends are part of a complex hybrid shoreline which will be reshaped by cultural and natural processes in the twenty-first century.

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WWW.CRAMWETLANDS.ORG: A COLLABORATION TOOL BUILT COLLABORATIVELY

The California Rapid Assessment Method (CRAM) is a standardized, cost-effective tool for assessing the health of wetlands and riparian habitats of California. It is designed to enable standardized ambient assessments at multiple scales: projects, watersheds, regions, and statewide. CRAM can be used to assess compensatory mitigation projects as well as restoration projects to help evaluate the performance of wetland and riparian protection policies and programs. The use of CRAM for ambient monitoring will, over time, help wetland managers and scientists quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in reference conditions. This information can then be used in the design, management, and assessment of projects. The CRAM website - www.cramwetlands.org – provides a integrated system for the management of all information about CRAM, including protocols, definitions, training materials, schedule of upcoming trainings, list of trainers and trainees, existing assessments and a data-entry section for entering CRAM information online. This system was built and continues to be developed as part of a multi-stakeholder collaboration. This talk will discuss that collaboration and how it has impacted the development and maintenance of the site.

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POPULATION GENETIC DIVERSITY OF *CIONA INTESTINALIS* SP. A ON THE PACIFIC COAST OF AMERICA

Diversity in genes linked to reproduction may impact population viability and demographic expansion. Here, we compare DNA sequence variation of a polymorphic exon of the gametic Self Incompatibility locus (SI) to a barcoding mitochondrial locus, CO1, commonly used in phylogeographic analysis. In addition to having highly polymorphic exons, the SI locus is directly linked to reproduction in the invasive tunicate *Ciona intestinalis* sp. A. We are using these two loci of *C. intestinalis sp. A* to compare 2 invaded regions of the Americas, north and south of the equator, that strongly differ in the availability of anthropogenic hard-substrate habitat (i.e. marinas and boats). In total, 8 sites were sampled (n = 172 individuals) in each hemisphere (4 each in California and in Peru). Preliminary results indicate that a polymorphic exon of SI (435 bp, $\pi = 0.189$) has higher variability than COI (720bp, $\pi < 0.007$). Geographic structure was detected with the CO1 locus between coasts (Fct = 0.2 p = 0.03) and within the region with less available habitat (Fst 0.29 – 0.31 $p < 0.0005$) suggesting a difference in regional patterns between hemispheres. The analysis of additional sequences of the SI within each geographic region may give further insight into sourcing or frequency of transport within and between regions. Further, the additional SI diversity may serve as an indicator of the potential for an invasive population to persist and expand its geographic range.

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COMPREHENSIVE MARSH AND WATER MONITORING GUIDES WETLAND MANAGEMENT PLANNING AND RESTORATION AT PRIME HOOK NATIONAL WILDLIFE REFUGE ON THE DELAWARE BAY

Prime Hook National Wildlife Refuge, managed by the U.S. Fish and Wildlife Service on the Delaware Bay, faces substantial management challenges in wetlands currently managed as coastal freshwater impoundments. Although once salt marshes, these impounded wetlands were altered by surrounding land use and eventually converted to freshwater impoundments as habitat for migratory birds. Manifestations of climate change, such as sea level rise and increased storm frequency, have recently led to dramatic overwash and saltwater intrusion into the impoundments, a subsequent collapse of wetland vegetation, and an increase in flooding in adjacent uplands and communities. In response, the Refuge initiated a comprehensive marsh and water monitoring program to provide critical data for guiding management decisions during the Refuge's recently-completed Comprehensive Conservation Planning (CCP) process. The monitoring program was instituted in cooperation with the Delaware Department of Natural Resources and Environmental Control's Coastal Management Program and the Delaware National Estuarine Research Reserve. The program consists of real-time monitoring of water level and salinity throughout the Refuge's wetland complex, routine analysis of nutrients and suspended sediments, establishment of surface elevation tables, salinity transects, flow velocity measurements, and more. The marsh and water monitoring program helped the Refuge to understand the impact of these drastic shoreline and wetland changes on management options, identify opportunities for adaptive restoration in the face of climate change, and communicate these concepts to the public. Data from the monitoring program provided sound scientific support for the Refuge's decision to plan for comprehensive tidal salt marsh restoration in the impacted wetland impoundments. This marsh restoration, still in the modeling and design phase, will represent one of the largest such restoration projects on the east coast.

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YOUNG AND RESTLESS: RAPID CARBON BURIAL IN A NEWLY EMERGENT MARSH

Salt marshes are potent sites of organic carbon burial, but the current body of evidence fails to account for some key issues. The first problem is geographic: we don't know how many marshes there are, and most studies are focused on the North Atlantic. But the second problem is more conceptual: we aren't accounting for the histories of marshes when we assess burial rates. Current databases of salt marsh carbon burial assume steady accretion rates, but marshes are dynamic biogeomorphic structures. Marshes are formed and subsequently undergo stress, degradation, collapse, and restoration; each of these processes will involve different trajectories of organic carbon burial. We demonstrate the potential impacts of these trajectories by considering a newly formed marsh at the Newport River (NC). Using known carbon densities and geochronologies from the site, we reconstruct the emerging marsh's pattern of carbon burial. As the site transitions from a submerged mudflat to an emergent marsh, we see a fivefold increase in organic carbon burial. Considering the processes behind salt marsh geomorphology and current records of carbon burial in the literature, we conclude that young marshes bury carbon more rapidly than mature ones. If young marshes are especially prevalent, global estimates of salt marsh carbon burial may be radically altered.

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BIOTIC INTERACTIONS MEDIATE THE EXPANSION OF BLACK MANGROVE (*AVICENNIA GERMINANS*) INTO SALT MARSHES UNDER CLIMATE CHANGE

Many species are expanding their distributions to higher latitudes due to global warming. The climate envelope approach is widely used to model and predict species distribution shifts with changing climates. Biotic interactions between species, however, may also

influence species distributions, and a better understanding of biotic interactions could improve predictions based solely on climate envelope models. Along the northern Gulf of Mexico coast, USA, sub-tropical black mangrove (Avicennia germinans) at the northern limit of its distribution grows sympatrically with temperate salt marsh plants in Florida, Louisiana, and Texas. In recent decades, freeze-free winters have led to an expansion of black mangrove into salt marshes. We examined how biotic interactions between black mangrove and salt marsh vegetation along the Texas coast varied across 1) a latitudinal gradient (associated with a winter-temperature gradient); 2) the elevational gradient within each marsh (which creates different marsh habitats); and 3) different life history stages of black mangroves (seedlings versus juvenile trees). Each of these variables affected the strength or nature of biotic interactions between black mangrove and salt marsh vegetation: 1) Salt marsh vegetation facilitated black mangrove seedlings at their high-latitude distribution limit, but inhibited black mangrove seedlings at lower latitudes; 2) mangroves performed well at intermediate elevations, but grew and survived poorly in high and low marsh habitats; 3) the effect of salt marsh vegetation on black mangroves switched from negative to neutral as black mangroves grew from seedlings into juvenile trees. These results indicate that the expansion of black mangroves is mediated by complex biotic interactions. A better understanding of the impacts of climate change on ecological communities requires incorporating context-dependent biotic interactions into species range models.

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RESOLVING THE RUNOFF-MEDIATED CHANGES IN DYNAMICS OF DISSOLVED ORGANIC MATTER IN DIFFERENT BRANCHES OF A LARGE BIFURCATE ESTUARY - THE CHANGJIANG ESTUARY

The Changjiang Estuary is a large bifurcate estuary where its South Branch (SB) and North Branch (NB) is influenced by different hydrodynamic processes. The SB is the dominant pathway of Changjiang river discharge, while the shallower and narrower NB is dominated by salty water intrusion, especially in the dry season. To examine the dynamics of dissolved organic matter (DOM) in such complex environments, two optical methods (absorption and fluorescence spectroscopy) combined with dissolved organic carbon (DOC) analysis were used to characterize the properties of DOM samples collected in different seasons (April, July and October) of extreme drought year of 2011. The refractory DOM from the Changjiang River mainly flowed through the SB, but in the lower SB, the input from polluted Huangpu River contributes large amount of biolabile DOM, leads to not only an increase in the DOM level, but also a notable change in the chemical composition (and hence reactivity) of DOM. The DOC concentration, absorption coefficient and fluorescence intensities in the NB showed apparent conservative behavior in the wet season. However, during the dry season, noticeable addition was observed in the upper NB, indicating the occurrence of strong biogeochemical processes in the turbidity zone (TM) of the NB, although no influence of TM on DOM estuarine behavior was observed in the SB and the neighboring Hangzhou Bay. The reduction in Changjiang River discharge in dry season also resulted into the inverted flux of water and DOM from the NB to the SB, which was intensified by the extreme drought events in 2011. This study illustrated the regular mediation of estuarine DOM dynamics by monsoon-controlled seasonal changes of fluvial runoff in Changjiang River. Further study is warranted to include all branches in the estuarine chemistry study of bifurcate estuary.

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BIO-PHYSICAL INTERACTIONS IN A LARGE SUBMERSED PLANT BED IN UPPER CHESAPEAKE BAY

A prominent feature of the upper Chesapeake Bay is a large (>50 km^2) shoal (<2 m) flanked by deeper (3-10 m) channels. In summer months, the shallow area supports an expansive submersed plant bed. Data from a pilot study show changes in concentrations of several water quality parameters, including nitrate, phosphate, and suspended particles, as depth decreases and plant biomass increases. The magnitude of these gradients varies over a range of temporal scales, from hours to days and seasons. We hypothesize that water quality differences across the plant bed are the result of bed effects on local hydrodynamics (i.e., reduced flow velocity and increased water residence time in the shallows due to frictional drag, particularly when plants are present) and biogeochemical cycling (i.e., denitrification and phosphorous de-sorption). Here, we measure a suite of physical variables (current velocity, wave height, water depth) and biogeochemical parameters and processes (water column and porewater nutrient concentration, sediment nutrient flux, plant nutrient uptake) across space and time to test for effects of the bed on its surrounding environment and to infer potential mechanisms driving these effects. A better understanding of these bio-physical feedbacks can help elucidate the internal processes that influence the dynamics of such a large submersed plant system. Furthermore, while a portion of outflow from the Susquehanna River is diverted around the bed into the channels, a substantial volume of water also flows across the bed. Quantification of nutrient transformation rates within the bed may provide a preliminary measure of the extent to which this region of the Bay modulates nutrient inputs from the river.

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BIODIVERSITY AND ECOSYSTEM FUNCTIONING IN AQUATIC ANGIOSPERM COMMUNITIES

The knowledge of how plant diversity affects ecosystem functioning is still mainly based on terrestrial studies, while our understanding of such patterns in the marine environment is limited. To study whether aquatic plant species richness and identity affect ecosystem functioning in terms of e.g. primary production, epifaunal colonization, infaunal community structure and the stability of Zostera marina subjected to shading, four separate field experiments ranging temporally from a week to 3.5 months were conducted in the northern Baltic Sea. A replacement design was used with plants being grown in mono- and polycultures. The experimental plant species consisted of Z. marina, Potamogeton perfoliatus, P. pectinatus, P. filiformis and Zannichellia palustris. Plant richness affected epifaunal community variables weakly, but had a strong positive effect on infaunal species number and functional diversity, while plant identity strongly affected epifaunal amphipods. Plant richness increased the shoot densities of three plant species and enhanced the biomass production. Both positive complementarity and selection effects were found to underpin the positive biodiversity effects. Plant richness also affected the stability of Z. marina. Plants growing in polycultures lost proportionally less biomass than monoculture plants, which lead to higher resistance to shading. Further, monocultures gained biomass faster, which in turn, lead to faster recovery compared to polycultures. These results demonstrate that plant diversity affects ecosystem functioning and contribute to the growing knowledge of plant diversity being an important component of aquatic ecosystems. Diverse plant communities sustain higher primary production than comparable monocultures, affect faunal communities positively and enhance stability. Multi-species meadows add to coastal ecosystem functioning in the northern Baltic Sea and may provide services that are essential for human well-being.

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ABUNDANCE AND DISTRIBUTION OF FISHES AT ESTUARINE AND COASTAL SITES NEAR THE MOUTH OF THE SAVANNAH RIVER, GEORGIA

Estuaries and surf zones along the East Coast of the United States are dynamic environments that play a vital role as nursery habitats for numerous marine fish species. Approximately 70% of the commercial species in the North Atlantic are dependent on estuaries at some point during their life cycle. Accurate assessments of fish abundance and patterns of habitat use are necessary for the development of better management practices for commercially and recreationally important species. The purpose of this study was to characterize multiple life-history stages of the estuarine and shallow surf-zone fish assemblages near the mouth of the Savannah River over a temporal and spatial scale. Three different sampling gear were used: a seine net, a beam trawl, and a zooplankton net. Seine net sampling began in June 2012 and beam trawl and zooplankton net towing began in March 2013. Based on results of seining from June 2012 to February 2013, fewer individuals were collected at the estuarine site (Cockspur Island) (n=76) than the surf zone site (Tybee Island) (n=114). Both sites exhibited high biodiversity, but it was higher in the estuary (7.22) than in the surf zone (3.55). The greatest species diversity was found within the family Sciaenidae with 5 different species collected at the estuarine site and 4 at the surf zone site. In terms of abundance at the estuarine site, sciaenids represented 22% of the catch compared to carangids with only 3%. In contrast, carangids were more abundant (25% of the catch) than sciaenids (13% of the catch) at the surf zone site. Overall, this work supports the findings of previous studies in which sciaenids were commonly the most represented group in estuaries on the East Coast. Data from both the beam trawl and zooplankton net sampling are currently being analyzed and will be used to characterize the entire fish assemblage near the mouth of the Savannah River including larval recruitment to the area.

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TROPHIC STATE OF COASTAL LAGOONS OF THE VERACRUZ STATE, MEXICO (GULF OF MEXICO) RELATED TO WATERSHED LAND COVER

We present an evaluation of the trophic status of several coastal lagoons located in Mexico Gulf Coast based on two trophic indexes (Carlson Cla and TRIX) and its relationship with the land cover within the different watersheds surrounding each lagoon. The size of the systems studied range from small (La Mancha, 150 h) to large (Tamiahua; 77,000h). Also the communication with the adjacent sea is variable with systems permanently connected (Alvarado), to mostly closed (Grande-Chica). The watershed land cover surrounding these lagoons varies from relatively unaltered (Sontecomapan), to highly modified (Grande–Chica); strong erosion problems are frequent, which in turn will increase the sediment load decreasing transparency and therefore affecting primary production. Recently, it has been found that land use change has occurred rapidly in this coastal state with more than 36 % of its original forest lost since 1980.These changes will in turn affect the nutrients exported from these watersheds to estuarine-coastal areas. In terms of the trophic status, as an example, according to Carlson trophic index (Cla) most of the coastal estuarine systems are β-mesotrophic-to α-eutrophic with a tendency to increase with time based on studies performed during different time periods on some of them. We discuss our finding in the light of the rapid changes occurring in the area and the impact they can have in the ecological functioning of this productive ecosystems.

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IMPORTANCE OF ESTUARINE HABITATS FOR LARVAL AND JUVENILE FISHES IN DANGHANG BAY, KOREA

Field investigations have been conducted at two estuaries and one blocked-estuary in Danghang bay to examine the impact of a dike on estuarine ecosystem with special interests in changes of fish compositions and assemblages. We have investigated the composition of larval and juvenile fishes by various collection nets including beam trawl and seine nets from August 2011 to July 2012. Transportation of dike, flood protection dams, tidal or hydroelectric power barrages, and other obstructions block tidal flow on many rivers throughout the world. In recent decades, estuarine conservation and restoration efforts have attempted to reverse some of these human alterations to tidal and freshwater exchange by removing or altering existing water control structures (Williams and Orr, 2002). The purpose of our study is to determine, from occurrence of larval and juvenile fishes, what kind of fish species use two different kinds of estuary, and the impact of a dike on fish habitats will be discussed.

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USING MACROINVERTEBRATE ASSEMBLAGES TO DETECT RECOVERY STATUS IN ESTUARINE WETLANDS OF THE SALMON RIVER ESTUARY, OREGON

This research explores the utility of macroinvertebrate assemblages in tracking ecosystem functional recovery after restoration activities. The Salmon River estuary is a well-established site for studies on recovery of tidal marshes impacted by diking. In the 1960s, tidal flows into three marshes of the lower estuary were blocked by dikes to create agricultural pastureland. The U.S. Forest Service restored tidal inundation to these areas at 9-year intervals (in 1978, 1987 and 1996) by grading and removing dikes. A never-diked portion of the estuary serves as a reference. We examined the reestablishment of benthic invertebrate communities following the final dike removal (1996), first in 1998-2002 and again in 2010-2013, collecting benthic cores and physical data monthly from March to August. Univariate analyses assessed overall density, taxonomic richness, and density of specific taxa. We also identified indicator taxa apparently sensitive to marsh recovery condition. Overall densities and taxonomic richness correlated with marsh recovery time for the 1998-2002 samples. However, based on preliminary results, this pattern was not found in the 2010-2013 samples. Densities of two key amphipod genera (*Corophium* and *Eogammarus*) were lowest in the 1996 marsh for the 1998-2002 samples, but preliminary results for the 2010-2013 samples suggested densities comparable to those in other restoring marshes. Together these results implied continued marsh recovery. In contrast, some indicator taxa identified in 1998-2002 remained indicators in 2010-2013. We also compared the invertebrate assemblages among the marshes with non-metric multidimensional scaling to determine if they reveal a pattern of recovery or if distinct differences in community structure still exist. We hypothesize distinct differences among marsh assemblages and suggest these may be due to habitat differences related to marsh position as well as differences in methods of dike breaching and removal.

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HIGH MARSH AND MUDHOLES: FACULTY AND PEER MENTORING OF UNDERGRADUATE RESEARCHERS IN THE SALMON RIVER ESTUARY

Two major goals of our Oregon Sea Grant-sponsored research in the Salmon River estuary were 1) to assess estuarine recovery after dike removal by comparing macroinvertebrate communities in three recovering tidal marshes with a never-diked marsh and 2) to provide research experiences for biology and pre-education majors. Fifty-eight undergraduates participated in this research in 2010-2012 and mentoring occurred at several levels. In our first year, we recruited four biology majors to serve as field team leaders, orienting them to the study site and training them in field methods and leadership principles. Two of them constructed and tested field equipment and determined how to access one of the tidal marshes via canoe. That first year, field team leaders mentored students enrolled in our Marine Ecology course. They trained field teams of 4-6 students, organized gear, led students to sampling sites and supervised sampling. All participants also assisted in sample sorting and contributed to discussions that addressed issues related to multiple researchers and lack of experience. These discussions led to improved replicability of methods and reduction of our own environmental impact. Course participants who excelled in the field were recruited as field team leaders for subsequent years and experienced field team leaders were given higher levels of responsibility. Some students also developed related independent research projects. In 2011, pre-education students in our Biology for Elementary Schools course participated in the research; these students worked alongside Marine Ecology students in the field in order to forge peer-mentoring relationships that continued in the classroom as they developed estuarine-related K-12 activities. Overall, our research and education objectives were complementary, but at times we had to re-evaluate and adjust our approach in order to maintain a high quality research program while also meeting our educational objectives.

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TIDAL WETLAND COMUNITY RESPONSE TO VARYING LEVELS OF FLOODING BY SALINE WATER

A long-term data base (2000-2009) was used to evaluate tidal floodwater salinity and the resulting soil bacterial remineralization processs (methanogenic or sulfate reducing) at 54 substations, which included a variety of marsh and swamp communities along the freshwater/saltwater boundary of the Cape Fear River/Estuary, North Carolina, USA. During this decade, a variety of extreme climatic events, i.e. floods and droughts, occurred, but overall data reflected long-term, average conditions. At sites flooded by >1ppt saline water more than 25% of the time, wetlands consisted of varying types of tidal marsh. Temperate, tidal swamps were present at sites flooded by this level of saline water less than 12% of high tides. Wetlands receiving 1ppt saline water 16-25% of flood tides were in some state of transition from swamp to marsh. Once trees in tidal swamps are killed, the wetland moves inevitably towards a tidal marsh dominated by species of herbaceous vascular plants with varying tolerance to saline water. Flooding >25% of tides by >1ppt seawater converted soils in those wetlands from methanogic to sulfate reducing organic matter remineralization dominated systems >50% of the time. The point along an estuarine gradient where adjacent wetlands are flooded by >1ppt saline water less than 25%, but more than 12% is the zone of transition. The conversion of a tidal swamp to tidal marsh is not caused by salt water itself, but by sulfate present in seawater. Once a sufficient concentration of sulfate enters soils, sulfate reducing bacteria convert it into hydrogen sulfide, which is toxic to any wetland plant species not adapted to exposure to this toxic substance.. The incidence of flooding by high tides containing >1ppt salinity is an accurate predictor of functional change in wetland type.

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LESSONS LEARNED USING WATER QUALITY MODELS TO DEVELOP NUMERIC NUTRIENT CRITERIA FOR A GULF COAST ESTUARY

Pensacola Bay is a shallow, mesotrophic estuary located in the north-central Gulf coast of the US. In November 2012, the US Environmental Protection Agency (US EPA) proposed numeric total nitrogen (TN), total phosphorus (TP), and chlorophyll-a (chl-a) water quality criteria for this estuary to limit anthropogenic nutrient impacts associated with

phytoplankton blooms, seagrass loss, and hypoxia. Analysis using coupled hydrodynamic-water quality models was central to the effort because these models are well-suited to evaluating spatial and temporal distributions of water quality parameters in the context of the dynamic physical regime in estuaries. Seagrass habitats in the Bay have decreased in spatial extent and depth of colonization since 1960 and hypoxia (DO<2.0 mg l-1) occurs in up to 25% of the Bay's bottom waters, trends consistent with nutrient enrichment impacts around the world. Surprisingly, simulations of Pensacola Bay for 2002-2009 suggested that neither issue could be addressed via nutrient loading reductions. Recognizing the potential value and importance of water quality simulation models as tools for developing numeric nutrient criteria, we are using Pensacola Bay as a test case to further evaluate and improve their use for this purpose. A conceptual model guides selection of potentially important "target processes," which for Pensacola Bay include optical properties and sediment-water oxygen and nutrient fluxes, among others. We will conclude by suggesting key features that could be incorporated into a recommended protocol for evaluating simulation model applications for numeric nutrient criteria development in estuaries.

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COLLABORATION AS A PARADIGM FOR EFFECTIVE DECISION-MAKING

Collaboration can take many forms. In the products, processes, and frameworks showcased in this session, we see new kinds of collaborative models emerging in the domain of natural resource management. Both on the provider side of solutions development and the client side of stakeholder and policy-maker engagement, the collaboration paradigm has made significant in-roads. Open-source software is now well-established in service of state-funded projects as well as the world at large. And from these "open" efforts have emerged web map services and even data-as-a-service that further extends the possibilities for integrative analyses and coordinated efforts that span multiple development teams. Furthermore, stakeholders are often more closely involved in the planning and execution of technology-related projects. They are brought into a collaborative framework that invites their meaningful participation. What evidence can we show for these efforts? What impact are these changes exercising on actual decision-making? As today's session will show, today's tools are more than products. They represent a new process and a new orientation toward problem-solving. We invite our presentations to describe the ways that they are collaborating toward new solutions.

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MICROBIAL CIPHER: TRANSLATING MICROBIOME DATA TO EXPLORE AQUATIC ECOSYSTEMS

The sensitivity of microorganisms to environmental change has been well studied and documented throughout the ~100 year history of the field of microbial ecology. Increasingly, multidisciplinary studies are incorporating molecular biological approaches to reveal the taxonomic structure and metabolic function of microorganisms in marine, coastal and estuarine environments. While microbial ecological studies remain largely focused on a priori questions regarding the role of microorganisms in specific settings or under specific geochemical conditions, it is clear that molecular microbial ecology studies have potential to reveal information about the co-evolution of ecosystems and ecosystem feedbacks that have occurred in the past, as a result of contemporary events and aid in predicting the impacts of current and future environmental change. Molecular biological (tag-pyrosequencing), geochemical (bulk carbon pools, cation and anion gradients), physicochemical (salinity, temperature) and radiocarbon data obtained from the Alaska Beaufort Shelf will be explored to provide examples of how deciphering the composition of prokaryotic communities may reveal the lasting impact of historical contingencies and in the coastal environment.

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COUPLED REPRODUCTION AND SETTLEMENT, CONNECTIVITY, AND LOCAL RETENTION OF ROCKY SHORE METAPOPULATIONS IN AN UPWELLING REGION

Identifying marine population connectivity is important for designing effective marine protected area networks that will promote metapopulation persistence, but empirically determining population connectivity is challenging for microscopic larvae that typically develop for weeks in the plankton. Many estimates of larval dispersal have relied solely on coastal oceanography and larval settlement patterns while neglecting reproductive output. We estimated population connectivity of a model species of crab, Petrolisthes cinctipes, using a hierarchical Bayesian modeling approach that has been used in seed dispersal studies. We combined prior estimates of larval dispersal (dispersal kernel) based on nearshore currents with field data of habitat quality, larval production and post-larval settlement from populations along the California coastline. Counter to conventional wisdom, our model suggests that local retention and coupling of reproductive output and larval settlement may be common for a species that develops for a month on the inner shelf in a region of strong, persistent upwelling. This approach improves quantitative estimates of population connectivity that may be used for the adaptive management of California's marine protected area networks.

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LONGITUDINAL VARIATION IN BENTHIC TROPHIC NETWORK ALONG A TRANSECT FROM ESTUARY TO OFFSHORE IN THE GWANGYANG BAY SYSTEM OF KOREA

To highlight trophic dynamics of benthic food web in a temperate estuarine bay system (Gwangyang Bay of Korea), carbon and nitrogen stable isotopes of macrobenthos were analyzed along with planktonic and benthic community structure along a longitudinal transect across estuary to offshore for spring and fall 2012, and winter 2013. In addition, biomasses of major primary producers (i.e. phytoplankton, microphytobenthos, and seagrass) were quantified at a whole bay scale by kriging technique to elucidate their importance as trophic base of benthic food web. As demonstrated using a self-organizing map, three distinct communities were separated by environmental conditions: 1) low-saline estuarine community, 2) within-bay community, and 3) offshore community. $\delta^{13}C$ values of sedimentary organic matter varied from riverine end-member (−25‰) in estuarine sites to marine end-member (−21‰) in offshore sites. A similar longitudinal $\delta^{13}C$ gradient was also observed in sestonic organic matter ranging from −24‰ to −18‰. Although $\delta^{13}C$ of macrobenthic taxa collected displayed broad ranges that spanned the values of organic matter sources, members of the estuarine community had much more negative $\delta^{13}C$ than those of the within-bay and the offshore communities, reflecting the $\delta^{13}C$ gradient of sedimentary and sestonic organic matter. In contrast, macrobenthos in the latter two communities showed broader $\delta^{13}C$ ranges than that of the estuarine community and some of them had much less negative $\delta^{13}C$ values than that of sestonic organic matter. This result indicates high incorporation of riverine organic matter to estuarine benthic food web and of in situ benthic producers to the within-bay and the offshore food web. Such a trophic importance of benthic producers to the within-bay and the offshore food web was confirmed by standing crops of phytoplankton, microphytobenthos, and seagrass accounting for 21, 17, and 25 ton, respectively, as a carbon equivalent in the whole area within the bay.

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LINKING SEAGRASS STATUS TO HIGH-FREQUENCY WATER QUALITY MONITORING IN THE CENTRAL INDIAN RIVER LAGOON, FLORIDA

Seagrass and high-frequency water quality monitoring has been conducted since 2005 along a water quality gradient near Vero Beach and Fort Pierce in the Indian River Lagoon (IRL). Temperature, salinity, dissolved oxygen, pH, turbidity, and chlorophyll *a* have been continuously monitored with datasonde multiprobes; color, suspended solids, nutrients, and light attenuation coefficients (K) are measured weekly. From north to south, salinity increases, while turbidity, color, suspended solids, and chlorophyll *a* (all attenuators of light) decrease, as do nutrients and K; seagrasses grade from near-monospecific beds of *Halodule wrightii* to more diverse, mixed communities of *H. wrightii, Syringodium filiforme*, and *Thalassia testudinum*. Water quality generally improved during the study period, primarily due to reduced precipitation (10-15% lower than 50-year means). Despite significant interannual differences in water quality, seagrass cover was stable through 2009. From 2009 to 2012, cover decreased at 5 of the 6 sites, consistent with a lagoon-wide seagrass decline, despite being well outside the 2011 "Superbloom" and 2012 brown tides, which led to a 45% loss in IRL seagrass. Both long-term spatial differences and recent declines in seagrass at these sites are due to reduced light attenuation ultimately associated with freshwater discharges in Vero Beach. Currently, this monitoring is being significantly enhanced by deployment of Land/Ocean Biogeochemical Observatory (LOBO) units and weather sensors to provide real-time, high-accuracy and high-resolution water quality/weather data as part of the Indian River Lagoon Observatory.

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SPATIAL DYNAMICS OF HABITAT UTILIZATION FOR INTERTIDAL OYSTER REEF COMMUNITIES IN FRAGMENTED HABITATS

The eastern oyster, Crassostrea virginica, is an important ecological and economic estuarine organism whose population is in decline due to various anthropogenic impacts. The decline in oyster abundances creates fragmentation within and among reefs, which has landscape impacts including altering edge to interior habitat ratios at multiple scales. Additionally, oysters are ecologically essential to estuaries because they are ecosystem engineers that create structure and habitat for organisms in areas that would otherwise be open substrate. As part of a larger study, we evaluated spatial dynamics for oyster density and resident reef macrofauna density and community composition; specifically focusing on the relationship between edge and interior, oyster reef size, and whether the reef was an isolated patch or a contiguous reef fringing marsh habitat. Over two years oyster and resident reef macrofauna communities were examined from edge to interior regions for three different size classes of natural fringing and patch intertidal reefs and three size classes of created reefs in southeastern North Carolina. Oyster densities demonstrated both an edge vs. interior and habitat size effect; with increased densities of oysters towards interior locations and greatest densities on intermediate sized reefs. Overall, resident macrofauna densities followed oyster patterns, with increased densities at the interior reef locations. This study indicates oyster reefs cannot be considered as uniform wholes, but may differ substantially with landscape characteristics.

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SEASONAL GROWTH AND SENESCENCE OF A *ZOSTERA MARINA* SEAGRASS MEADOW ALTERS WAVE-DOMINATED FLOW AND SEDIMENT SUSPENSION WITHIN A COASTAL BAY

Seagrass meadows create significant benthic structure, which attenuates wave energy and near-bottom currents. This attenuation can reduce bottom shear stresses and enhance sediment deposition, thus increasing light availability to the benthos. To quantify how meadow structure influences the physical environment, tidally driven flows, waves and suspended sediment concentrations were monitored seasonally within a *Zostera marina* seagrass meadow located in a shallow (1-2 m depth) coastal bay. Velocities were reduced approximately 60% in the summer and 40% in the winter by the seagrass meadow compared to an adjacent unvegetated site. Additionally, wave heights were dampened by the meadow for all seasons except during winter when meadow development was at a minimum. Although wave heights were attenuated, orbital motions caused by waves were able to effectively penetrate through the canopy, inducing wave-enhanced bottom shear stress (τb). Within the seagrass meadow, τb was greater than the critical stress threshold (= 0.04 Pa) necessary to induce sediment suspension 80 to 85% of the sampling period in the winter and spring, but only 55% of the time in the summer. At the unvegetated site, τb was above the critical threshold greater than 90% of the time across all seasons. During low seagrass coverage in the winter, near-bed turbulence levels were enhanced, likely caused by stem-wake interaction with the sparse canopy. Reduction in τb within the seagrass meadow during the summer correlated to a 60% reduction in suspended sediment concentrations; but in winter, suspended sediment was enhanced compared to the unvegetated site.

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DEVELOPMENT OF A NATIONAL-SCALE INDICATOR OF BENTHIC CONDITION FOR THE NATIONAL COASTAL CONDITION ASSESSMENT

The US EPA has evaluated the application of a national-scale indicator of estuarine benthic condition for the National Coastal Condition Assessment (NCCA). Historically, in the National Coastal Condition Reports (NCCR I-IV), estuarine benthic condition was assessed by applying multiple regional multimetric benthic indices that were developed using different statistical methods, component metrics, and numerical scales. Combining these regional indices to assess estuarine benthic condition nationally has been criticized in previous peer reviews of the NCCRs. The US EPA recognized the potential value of having an estuarine benthic indicator that could be applied uniformly for future NCCRs. The Multivariate AZTI Marine Biotic Index (M-AMBI), developed in Europe, is widely used across different waterbodies to assess marine benthic condition under the Water Framework Directive (WFD). The M-AMBI combines AMBI, taxa richness, and diversity in a factor analysis to explore the response of soft-bottom communities to natural and anthropogenic changes in water quality, integrating long-term environmental conditions. We evaluated the applicability of M-AMBI to the NCCA through statistical validation analyses to ensure reasonable correspondence with both the original regional benthic indices and environmental stressors. The advantages of using M-AMBI in the NCCA include 1) use of a common approach that can be applied nationally with regional calibration; 2) acceptance as a valid method of assessing benthic conditions in Europe; and 3) an assessment scale that is the same across the US. We will present the modifications we have made to M-AMBI for US estuaries and the results of validation analyses to test the applicability of M-AMBI for use by the NCCA.

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THE RESPONSE OF *SPARTINA ALTERNIFLORA* TO MULTIPLE STRESSORS: EUTROPHICATION, PRECIPITATION CHANGES, AND SEA LEVEL RISE

A four month experiment using greenhouse mesocosms was conducted to analyze the effects of eutrophication, sea level rise, and precipitation changes on the salt marsh plant *Spartina alterniflora*. Pots containing plants were placed in six 600L tanks that received seawater pumped from Narragansett Bay and were filled and drained on a semidiurnal tidal regime. The mesocosms were set up as a 3x3x2 factorial design (n=4) to measure three levels of freshwater precipitation (ambient daily rain, biweekly storm, and drought), three elevation levels (low, middle, and high), and two levels of eutrophication (ambient seawater control and nutrient addition of fertilizer). The goal was to analyze the effects these multiple stressors would have on the *Spartina* plants in a controlled greenhouse setting. Results showed varying physiological responses to all sets of treatments. *Spartina* plants in the storm and drought treatments had significantly less above and belowground biomass than those in ambient rain treatments, while plants at the high and middle elevation had significantly greater biomass than those at the low elevation. The treatments for control and eutrophic had more varied results. While nutrients had no effect on overall above and belowground biomass, fertilized pots had significantly higher stem counts and more fine roots than pots in the control tanks. The fertilized pots also showed significantly greater carbon dioxide emissions as measured by soil respiration across the low and middle elevations compared to control pots at the same elevations. However, the control pots had significantly more coarse roots and rhizomes, which are important to building peat in biogenic marshes. These results demonstrate the importance of short-term effects of accelerated sea level rise, changing precipitation patterns, and nutrient over-enrichment on *Spartina alterniflora*, and the potential impacts these effects may have long-term on New England salt marshes.

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FROM EARTH AND OCEAN: INVESTIGATING THE IMPORTANCE OF UPSTREAM LANDSCAPES, SALMON AND CROSS-ECOSYSTEM SUBSIDIES TO ESTUARINE INVERTEBRATES

A large body of research has demonstrated that resource availability is a fundamental force shaping ecological systems and that resource subsidies can alter nutrient dynamics and shape community structure in recipient habitats. The effects of subsidies can be mediated by species-specific traits and the character and connectivity of adjacent habitats. We used mixed-effects models and multi-model inference to investigate the effects of upstream watershed size, structure, and adult spawning Pacific salmon (*Oncorhynchus spp.*) on Dungeness crabs (*Metacarcinus magister*) and softshell clams (*Mya arenaria*) across multiple estuaries. We conducted our research in intact watersheds on the central coast of British Columbia. The movement of terrestrial material from upstream headwaters to the coast, and the 'counter-flow' annual pulses of returning salmon, provide ample opportunity to investigate the interconnectivity between ecosystems. For both crabs and clams, isotope ratios were related to watershed- and individual-level predictors. Crab $\delta^{15}N$ was best explained by upstream salmon density, watershed size and red alder (*Alnus rubra*) while $\delta^{13}C$ was predicted by watershed size and crab shell age. Crabs were more abundant in larger estuaries and were heavier in estuaries situated below large watersheds. Softshell clam $\delta^{15}N$ was best described by clam size and salmon density. In addition to clam size and salmon density, clam $\delta^{13}C$ was also correlated with watershed size and estuary temperature. For both isotopes, the effect of salmon decreased with increasing distance between clams and river mouths. Our results confirm that both terrestrial- and salmon-derived nutrients

are important contributors to the resource base in estuarine invertebrate communities of the Pacific Northwest.

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COMPARISON OF PHYTOPLANKTON DYNAMICS IN MID-ATLANTIC ESTUARIES USING LONG-TERM DATA

Climate conditions expressed as drought-flood cycles and tropical storms / hurricanes strongly influence phytoplankton dynamics in estuarine and coastal ecosystems of the mid-Atlantic region. Historical and recent data on floral composition, biomass, and primary productivity spanning 5-6 decades are presented for two contrasting estuaries, Chesapeake Bay (CB) and Albemarle-Pamlico Sound / Neuse River (APS-NR). Our goal is to illustrate long-term trends against a backdrop of strong climatic forcing that underlies interannual variability. Data sources include historical observations (1950-1983), monitoring cruises (1984-present), individual research programs (1982-2005), and aircraft remote sensing of ocean color (1989-present). We use these several time-series to quantify effects of key properties linked to freshwater flow on phytoplankton dynamics. Specific results include seasonal, interannual, and decadal variability of species composition, chlorophyll, and primary productivity. Data from these sources are combined with climate analyses and statistical and biogeochemical models to support our current understanding, leading to predictive capabilities for these complex ecosystems.

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ORGANIC MATTER AND NITRATE INFLUENCE ANOXIC NITROGEN CYCLING PATHWAYS IN MARINE SEDIMENTS

In anoxic marine sediments, organic matter and nitrate have been hypothesized to influence the relative importance of anammox, denitrification, and dissimilatory nitrate reduction to ammonium (DNRA), three nitrate reduction pathways. However, few experiments have directly tested this hypothesis. We conducted an experiment using coastal Rhode Island sediments (57m deep), wherein we manipulated both nitrate and sediment organic carbon loadings. Thin discs of sediment were placed into flow-through, anoxic incubation chambers and received either low or high nitrate loading and either low or high sediment organic carbon loading. Over six weeks, we measured potential rates of anammox, denitrification, and DNRA using 15N-labeled nitrite. In treatments with added organic carbon, potential anammox and denitrification rates were initially inhibited, while nitrite was rapidly consumed by DNRA. After depletion of the labile organic carbon pool, both anammox and denitrification resumed and were relatively higher than DNRA in the treatment with high carbon and high nitrate. In treatments with low sediment organic carbon, denitrification was the primary nitrite reduction pathway, followed by anammox, then DNRA. In these treatments, relative anammox was highest when nitrate was high. Overall, the availability of labile organic carbon favored DNRA over denitrification and anammox, but denitrification dominated when the labile organic carbon pool was depleted. In conditions of lower organic carbon, relative anammox rates were enhanced in the presence of high nitrate. Our approach provides a mechanistic framework for elucidating environmental controls on anoxic nitrogen cycling pathways in marine systems.

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EFFECTS OF RESUSPENSION ON SEDIMENT BED OXYGEN CONSUMPTION: A NUMERICAL MODELING STUDY FOR THE LOUISIANA SHELF

Though it enhances the exchange of porewater and solids with the overlying water, the role that sediment resuspension and redeposition play in biogeochemistry of coastal systems is debated. Numerical models of geochemical processes and diagenesis have traditionally parameterized relatively long timescales, and rarely attempted to include resuspension. Meanwhile, numerical models developed to represent sediment transport have largely ignored geochemistry. Here, we couple the Community Sediment Transport Modeling System (CSTMS) to a biogeochemical model within the Regional Ocean Modeling System (ROMS). The multi-layered sediment bed model accounts for erosion, deposition, and biodiffusion. It has recently been modified to include dissolved porewater constituents, particulate organic matter, and geochemical reactions. For this talk, we explore the role that resuspension and redeposition play in biogeochemical cycles within the seabed and in benthic boundary layer by running one-dimensional test cases designed to represent a 20-m deep site on the Louisiana Shelf. The model accounts both for oxygen consumed within the sediment bed, and within the overlying water. Results from this are contrasted to calculations from an implementation similar to a standard diagenesis model. Comparing these, the results indicate that resuspension acts to enhance sediment bed oxygen demand, as well as oxygen consumption in the water column. During a cycle of erosion and deposition, oxygen from the overlying water can be added to the pore water of newly deposited sediment, while “oxygen demand units” are injected into the water column during erosion of anoxic sediment. For this reason, resuspension events impact the timing of oxygen demand, with pulses of oxygen consumption occurring during and shortly after resuspension cycles. The magnitude of sediment bed oxygen demand is especially sensitive to the model’s treatment of diffusion across the sediment – water interface.

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OPTIMIZING ESTUARIES

A great deal of our efforts to link science and management hinge on the supposition that regulatory tools such as total maximum daily loads (TMDLs) or water quality criteria can be predicted based on numerical models that consider an array of interacting variables. In the case of water quality models, we further assume that titrating nutrient inputs or freshwater discharge in modeled scenarios will result in simulated responses that inform a desired restoration outcome, such as reduced hypoxia or increased light availability for submerged vegetation. Here we explore the presumption that estuaries can be optimized to meet water quality restoration goals, with a historic focus on control of nutrient inputs. We provide a synthesis of how the concept of optimization has been applied to problems of estuarine water quality within the framework of optimal control theory. To further illustrate this idea, we offer a case study from an experimental manipulation of whole-estuarine aeration to explore the potential of optimizing rates of benthic-pelagic nutrient fluxes and denitrification.

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INTERACTIONS BETWEEN MICROPHYTOBENTHOS AND MACROFAUNA REGULATE INTERTIDAL SEDIMENT STABILITY

Biological activities within sediments affects its stability, but the interactions between sediment stabilizing microphytobenthos (MPB) and destabilizing bioturbating macrofauna have rarely been tested experimentally in situ. In a large-scale field study, we manipulated 56 (1 m2) plots on an exposed intertidal sandflat; limiting MPB activity using shade cloth and creating a gradient (0-200 ind. m-2) in the bioturbation/grazing pressure exerted by the deposit-feeding bivalve Macamona liliana. Three months after the manipulation, sediment stability (erosion threshold and rate) in the plots was measured using a core-based device (EROMES) and the sediment properties and macrofaunal community composition ascertained. Although shading did not impact MPB biomass, differences in macrofaunal abundance were detected between shaded and non-shaded areas. Distance-based linear regression models indicated ≤ 36 % of the variation in erosion data could be explained by a combination of sediment grain size (≤ 23%, $p \leq 0.03$), MPB indicators (chlorophyll a: phaeophytin ≤ 13%, $p \leq 0.03$) and macrofauna (abundance 19%, $p = 0.003$ and richness 15%, $p = 0.01$). As expected, MPB indicators were positively correlated with sediment stability whereas a decrease in sediment stability was correlated with increased macrofaunal abundance. Our results demonstrate that even for sandy sediments exposed to frequent reworking by tidal currents and wind-generated waves, biological interactions significantly impact sediment stability.

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CONSIDERING SEA LEVEL RISE IN ESTUARY CONSERVATION PLANNING ON THE BRITISH COLUMBIA COAST

The Pacific Coast Joint Venture (PCJV) is a conservation partnership of government agencies, ENGOs and industry extending from California to Alaska. Protecting estuaries is the cornerstone of PCJV programs along the British Columbia (BC) coastline, where the focus is on providing habitat for wintering and migrant waterfowl and other water-associated birds. In 2007 the Canadian PCJV partners prioritized 442 estuaries for conservation action based on their biological value as measured by bird use and four other values (herring spawns, estuary size, plant communities, and salt marsh habitat). While the ranking scheme is a useful tool, it was based on a limited window of information, and we are actively working to improve it by increasing the input of biological data. We also recognize that environmental influences such as climate-associated sea level rise (SLR) have the potential to increase or decrease the bird foraging value of estuaries depending on the morphology of the subtidal, intertidal and suprtatidal zones. An improved understanding of estuary morphology will be necessary to accurately forecast SLR-related gains and losses in estuarine zones, and to better allocate conservation resources. There has been considerable effort to model SLR effects on US estuaries using SLAMM (Sea Level Affecting Marshes Model). However, on the BC coast there has been limited use of SLAMM due to a lack of up-to-date vegetation data and suitable LIDAR imagery to provide elevations. Consequently we have undertaken a two-pronged approach in which we: 1) construct simpler models of SLR effects on estuarine foraging habitat at the broader coastal or landscape scale, and 2) continue more detailed SLR assessments at select estuaries using an ad-hoc approach to generating the requirements for SLAMM. We intend to incorporate model predictions into our conservation programs in the context of contingency planning and adaptation, and to communicate recommendations to decision-makers.

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BIOVOLUME OF ECOLOGICALLY IMPORTANT PHYTOPLANKTON SPECIES FROM TIME SERIES DATASETS

The biovolume of species from 16 time series were determined by making light microscope measurements for various geometrical shapes that were appropriate for that species. We eliminated freshwater species, cyanobacteria and benthic pennate diatoms and did not use identifications that have been made only to the genus level. The datasets were checked for taxonomic and nomenclatural synonymies using the WORMS data base, errors, misspellings, etc. We determined the biovolume for field grown species that occured in at least 5 of 16 datasets (generally these are the ~100 most common species which were mainly diatoms and dinoflagellates since they are easier to identify to the species level). The biovolume estimates from these time series should have a larger and more realistic coefficient of variation since there is substantial variation in environmental factors such as nutrients, light, temperature and salinity in the 16 field sites. Diatoms showed more vatiation in biovolume and especially seasonal biovolume, than dinoflagellates. Many of the other questions posed by WG 137 can use our biovolumes to convert the routine species abundance into biovolume and cell carbon to take into account the large difference in cell size of the various species.

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DEVELOPMENT OF A NATIONAL-SCALE FISH TISSUE CONTAMINANT INDICATOR FOR THE NATIONAL COASTAL CONDITION ASSESSMENT

Transforming measurable concentrations of chemicals found in whole-body fish and shellfish into an ecologically relevant indicator is not easily accomplished since few pertinent biologically protective contaminant-screening tools exist, and none have been published for use at a national scale. Previously, the National Coastal Assessment (2000-2006) used human-centric endpoints as proxies to elicit ecological inference from tissue contaminant concentrations. For the 2010 National Coastal Condition Assessment (NCCA), we have proposed an approach for calculating a fish tissue indicator based on USEPA's ecological risk assessment process. The approach estimates the relevant risk potential of food-based contaminant exposure to predatory fish and piscivorous wildlife (receptors). Risk potential, accounting for receptor body weight, ingestion rate, and other exposure factors, is derived by calculating the ratio of exposure concentration divided by the concentration known to produce an adverse toxicological effect or, alternatively, not produce an adverse effect. The final series of calculations produces results that equate to threshold values for evaluating measured tissue contaminant concentrations as indicator values appropriate for NCCA's probability analysis. Modifications were made to the methods to ensure that upper and lower threshold values were nationally applicable and protective of most, if not all, ecological receptors. The approach and results demonstrating the applicability and viability of using the ecological risk assessment methodology to generate a fish tissue contaminant indicator for use in the assessment of the Nation's coastal resources are presented.

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SULFIDE INTRUSION AND DETOXIFICATION IN SEAGRASSES ECOSYSTEMS: HOW TO AVOID ROTTING FEET

Sulfide intrusion in seagrasses represents a global threat to seagrasses and thereby an important parameter in resilience of seagrass ecosystems. In contrast seegrasses colonize and grow in hostile sediments, where they are constantly exposed to invasion of toxic gaseous sulfide. Remarkably little is known about the strategies of seagrasses to survive sulfide intrusion, their potential detoxification mechanisms and sulfur nutrition in general. By a global review of sulfide intrusion, coupled with a series of field studies and in situ experiments we elucidate sulfide intrusion and different strategies of seagrasses to sustain sulfide intrusion. Using stable isotope tracing, scanning electron microscopy with x-ray analysis, tracing sulfur compounds combined with ecosystem parameters we found different spatial, intraspecific and interspecific strategies to cope with sulfidic sediments. 1) Tolerance, by elimination (eg. *Zostera marina*); where we found precipitation of sulfide as non-toxic elemental sulfur on the inner wall of the root lacunae. 2) Utilization (eg. *Z. marina*), where seagrasses detoxify and incorporate sulfides by active uptake and metabolize to sulfate, representing a non-toxic storage compound. 3) Avoidance, by barriers in tissue (eg. *Posidonia oceanica*) and/or radial root oxygen loss to reoxidize sulfide. Foliar sulfate and metabolic uptake of gaseous sulfide via roots as main sulfur source represents an evolutionary adaption of submerged plants, to our knowledge not present in terrestrial plants at that level. Sulfide is not necessarily toxic but used as sulfur nutrition, presupposing healthy seagrass ecosystems that can support detoxification mechanisms. Presence or absence of those mechanisms determines susceptibility of seagrass ecosystems to sediment sulfide and thereby their resilience, which is important knowledge for management of seagrasses under global pressure.

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THE ROLE AND CONSEQUENCES OF COLLABORATION IN AN ONGOING VESSEL TRAFFIC RISK ASSESSMENT FOR PUGET SOUND

Commercial vessel traffic through the shared waters of Washington and British Columbia is projected to increase over the next decade. A George Washington and Virginia Commonwealth University vessel traffic risk assessment (VTRA) is being conducted utilizing vessel tracks recorded in 2010 by the US and Canadian Coast Guards. Its purpose is to depict a baseline of oil spill risk and the magnitude and geographic extent of changes in relative risk associated with potential projects pursuing permits for new shipping terminals (e.g., Trans Mountain Pipeline Expansion Project, Gateway Pacific Terminal, and several in Port Metro Vancouver). The risk assessment follows a participatory model based on the "collaborative analysis" method (Busenberg 1999). It has been informed by expert judgment among collaborative coalitions of stakeholders and brokered to promote cooperation (per Weible 2008). Specifically, the VTRA Steering Committee, largely composed of professional mariners from the Puget Sound Harbor Safety Committee and the Puget Sound Partnership Oil Spill Work Group, is guiding comparisons between traffic in 2005 and 2010, and simulations of more than 1500 additional potential deep draft vessel arrivals annually through the system by 2025. Based on the results of those simulations, the Steering Committee will propose (and model) interventions to mitigate any substantial changes in risk to inform a regional vessel traffic risk management strategy. Weible (2008) proposed that the use of expert based information in such a collaborative framework (as compared to unitary or adversarial subsystems) tends to: (1) favor the instrumental use of science, (2) limit its political use, and (3) promote learning across coalitions. In this paper, we evaluate Weible's hypotheses with respect to the current VTRA and whether the effort is likely to lead to policies that are "voluntary, win–win, and flexible"- as predicted.

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AMERICAN INDIAN STUDENT-DRIVEN RESEARCH AT THE SALISH SEA RESEARCH CENTER

Working with tribal communities brings an important prospective to ecological questions and a long-term view of natural resources. The new Salish Sea Research Center, establishes Northwest Indian College as a research institution, providing the resources necessary for tribal students to research environmental health from a Native perspective. The Salish Sea Research Center (SSRC) is a brand new 4,200 square foot facility dedicated to research important to tribal people. The center brings tools and technologies to our students on the reservation to research the questions they find most compelling in a supportive, scientific environment. For the communities we serve, this means local students now have the training and tools needed to pursue environmental research on their reservation. More importantly, tribal people can ask the questions that matter most in their lives using a mixture of traditional and non-traditional methods without having to rely on non-tribal or off-reservation resources. Generally the research carried out in the SSRC can be described under two umbrellas: environmental health and the history of human interaction with land and seascapes. SSRC environmental health research centers on work that promotes the healthy, clean, and vibrant environments that sustain tribal people. To understand the human footprint on Salish Sea, we acknowledge that people have always been here and in this center we ask what lessons can be learned about how the ancestors promoted sustainability, how they interacted with the Salish Sea in a respectful manner.

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THE EFFECTS OF ELEVATED CO_2 ON THE GROWTH AND TOXICITY OF FIELD POPULATIONS AND CULTURES OF THE PSP-PRODUCING DINOFLAGELLATE, *ALEXANDRIUM FUNDYENSE*

The effects of eutrophication-enhanced coastal acidification on the growth and toxicity of the PSP-producing dinoflagellate, *Alexandrium fundyense*, were examined in both field and culture studies. The temporal and spatial dynamics of *Alexandrium* densities, and pCO_2 concentrations were assessed in Northport Bay, New York, a eutrophic embayment that experiences annual *Alexandrium* blooms. Additionally, a series of semi-continuous culture experiments were conducted using strains of *Alexandrium* isolated from Northport Bay (NPB8) and the Bay of Fundy (CCMP 2304) to constrain the effects of CO_2 and nutrient levels on the growth and toxicity of *Alexandrium*. pCO_2 concentrations present during *Alexandrium* blooms approached 1800µatm, with levels increasing over the duration of the bloom and being highest in regions with the greatest cell abundances. Field experiments performed using the range of pCO_2 levels recorded in Northport Bay (390 – 1500 µatm) demonstrated that *Alexandrium* densities were significantly enhanced by higher levels of pCO_2. Growth rates of both *Alexandrium* strains were significantly higher (16 -190%; $p<0.05$) at elevated levels of CO_2 (~ 800- 1900µatm) compared to the control level of ~390µatm. In addition, the total toxin content (fg STX eq. $cell^{-1}$) of the Northport Bay strain increased (79 – 205%) when grown under elevated CO_2 levels compared to the control. The causes of elevated levels of pCO_2 in regions hosting *Alexandrium* blooms and implications of acidification in promoting bloom events will be discussed.

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MEASUREMENTS AND MODELING: METHODS OF ESTIMATING N INPUTS TO A SHALLOW, GROUNDWATER-FED LAGOON

West Falmouth Harbor, a shallow groundwater-fed estuary located on Cape Cod, MA, has seen a large increase in nitrogen (N) load over the past decade or so following the construction of an up-gradient wastewater treatment facility that contaminated a groundwater aquifer flowing into the harbor. Understanding the magnitude and patterns in the N load from the watershed is important to interpreting the observed changes in the ecosystem over the past nine years; however, monitoring N input to systems fed largely by groundwater is problematic. We use a combination of traditional and novel methodologies to estimate the change in N load over time. Land use modeling and deposition studies give us an estimate of the background loading rates, and by combining well sampling with groundwater modeling as presented in Ganju et al. 2012 and a nitrate:salinity mixing model we can calculate the total loading rate. We estimate that N load to the estuary has increased 3-fold as a result of the contamination to the aquifer. Despite the implementation of N removal technology at the wastewater plant in 2006, we have not seen a reduction in load as of early 2013, but we expect to observe this within the next 1 to 2 years.

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TOOLS FOR MANAGING SEDIMENT IN LOUISIANA

Sediment is critical to the sustainability of coastal Louisiana, and being sediment-limited, proper management of sediment resources is critical. Louisiana's 2012 Coastal Master Plan prescribes billions of dollars in sediment diversion, barrier island and marsh creation projects. To meet the sediment needs of this ambitious plan, Louisiana has developed a comprehensive Louisiana Sediment Management Plan (LASMP) which facilitates the inventory of sediment resources, management of relevant datasets, and provides tools for project planners and managers to efficiently manage fluvial and offshore sediment resources. This plan also considers borrow area management issues and policy issues which may need to be refined to maximize the sediment available for restoration. Four primary components that direct State efforts toward a more formal Regional Sediment Management (RSM) approach include: 1) sediment management 2); borrow area considerations; 3) policy and regulations; and 4) coordination with Federal, State, and other stakeholders. Components that have already been developed include a Delta Sand Search Model (DSSM), the Louisiana Sediment Resource Database (LASARD), monitoring programs such as the Barrier Island Comprehensive Monitoring (BICM) program, and a set of regional sediment distribution maps identifying known sediment resources in coastal waters and the Mississippi River. Finding adequate quantities of restoration-quality sediments in the Mississippi and Atchafalaya Rivers, and within State and Federal OCS waters is fundamental to the state implementation of RSM initiatives. The long-term goal for these tools is to enhance State planning capabilities to optimize sediment resources, capitalize on synergistic project opportunities, reduce project costs, maximize land-building potential, and ensure projects have the necessary sediment available for 50-yr planning horizon of the 2012 Coastal Master Plan.

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THE ROLE OF LAND USE IN RECOVERY FROM PHRAGMITES REMOVAL

Patterns of land use can result in disturbance that alters nutrient delivery to estuaries, potentially impacting the outcome of restoration efforts. These disturbances can foster the establishment and spread of invasive species and impact the recovery of native plant communities following removal of invasive species. We explore this issue by examining the relationship between land use in estuarine watersheds and the recovery of wetland vegetation following the removal of Phragmites australis in nine subestuaries of Chesapeake Bay dominated by forest, agriculture, or development. Here we present the pre- and first year post-herbicide treatment results on plant community, seedbank composition, and nutrients across land use types. In each subestuary, we established plots where P. australis is intact, an herbicide treatment, and a native reference. Prior to herbicide treatment, seedbank composition did not differ between the native marshes and P. australis-dominated marshes, indicating that the seedbank is driven by processes operating at the watershed level. In the second year, the seedbank was related to the canopy vegetation. Based on ordinations, native reference site vegetation clustered according to land use and by watershed, while P. australis plots were a uniform monoculture across all sites prior to treatment. Following herbicide, some P. australis remained in the treatment plots, with other species becoming established. The vegetation in reference sites varied by land use and by watershed. Ammonium and phosphate varied by land use prior to herbicide treatment and ammonium varied significantly by vegetation type. Forested and developed watersheds had lower phosphate levels than agricultural watersheds in the first year, but not the second. Native vegetation had higher ammonium levels than P. australis or removal plots. We discuss our findings in the context of prioritizing watersheds for P. australis removal.

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EFFECTS OF TOPOGRAPHY ON THE FORMATION OF LOW OXYGEN WATERS IN PEARL RIVER ESTUARINE COASTAL WATERS

The Pearl River discharges a large amount of anthropogenic nutrients into the oligotrophic South China Sea. The eutrophication symptoms of the estuarine coastal ecosystem are not as pronounced as expected from the high nitrogen load. In estuarine influenced coastal waters south of Hong Kong, there have been hardly any reports of season-long hypoxic waters over coastal wide scale. However, there have been episodic events of hypoxic waters. For example, in late summer 2002, hypoxia was observed in the coastal waters south of Hong Kong and lasted for a week, but not in shallower waters. We constructed two layers model to demonstrate effects of shoaling on the formation of low oxygen waters. Using time series of data between deep stations (20 m) and shallower (10 m), we showed that shallow topography in near-shore waters and lack of low-speed winds appears to give a coastal ecosystem larger resistance to hypoxia.

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LANDSCAPE AND LOCAL INFLUENCES ON THE CONDITION OF CALIFORNIA'S BAR-BUILT ESTUARIES

Connecting marine, freshwater and terrestrial ecosystems, bar-built estuaries are complex and dynamic systems that provide a great diversity of habitat and ecosystem services. These unique but widespread systems provide critical habitat for many commercially important and endangered species. With a growing population, often centered on coastal confluences, these habitats experience varying degrees of alteration. Future alterations, increasing demand for freshwater and climate or sea level change all further threaten bar-built estuaries and the services they provide. In order to ensure the long-term health and productivity of these critical habitats, we need an increased understanding of their ecological functioning. An assessment methodology that is standardized throughout California is challenging for such complex and dynamic habitats, yet necessary to ensure comparable data and consistent direction of appropriate management. We developed the California Rapid Assessment Methodology (CRAM) for bar-built estuaries - a cost-effective, state-wide standardized manner of assessing bar-built estuary condition. We used a combination of GIS watershed scale measures of landscape stressors, and site level focal assessments (i.e. nutrient and vegetation data) on bar-built estuaries throughout California to validate CRAM. We found combinations of landscape (GIS), and local (CRAM, and focal data) metrics to not only assess the condition of the bar-built estuary, but elucidate the scale at which stressors were influencing bar-built estuary condition. We summarize our results for the condition of over 60 bar-built estuaries throughout California, and how these are linked to landscape and local measures of stress. We further present how this multi-scale approach can be used to direct management to simultaneously improve local (stream), watershed, and downstream bar-built estuary condition.

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SHIFTING SPECIES INTERACTIONS AND THE TROPICALIZATION OF THE NORTHERN GULF OF MEXICO

Temperatures are rising in most temperate and polar environments, and one well-documented effect of these increases is a poleward range shift by a wide variety of terrestrial and aquatic species. In the northern Gulf of Mexico an increasing number of tropical species has recently become established among the extant warm-temperate fauna. These include manatees, green turtles, warm-water coral species, black mangroves, and a diversity of tropical fish species. The impact of these tropical species may be profound, primarily because temperate species are restricted from shifting northward by the adjacent North American land mass. Thus, as tropical species expand northward in the Gulf, they must interact with the extant species and potentially compete for essential resources or become prey for each other. In this talk we focus on tropical immigrants capable of transforming the vast and highly productive seagrass systems of the northern Gulf, including the green turtle, the manatee and several species of herbivorous parrotfishes. Increases in these herbivores would likely shift detritus-based food webs in seagrass meadows to those dominated by direct consumption of seagrasses. We provide estimates of the expected consumption rates of these tropically-associated seagrass herbivores, and predict that the consequences of the increased tropicalization of northern Gulf meadows will be: substantially reduced standing crops and structural complexity of seagrass meadows; increased energy flux through grazing food webs; and a greatly reduced nursery role of seagrasses that will result in much smaller adult populations of species that rely on seagrasses as nurseries. We conclude by noting some of the additional changes that can soon be expected in other nearshore habitats and their animal associates.

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COLLABORATIVE ADAPTATION PLANNING FOR SEA LEVEL RISE AROUND THE SAN DIEGO BAY

San Diego is a region defined by its relationship with the coast and heavily invested in its coastal communities. San Diego Bay, in particular, is a treasured regional asset, the anchor of the regions' tourism and military economies, host to the fourth largest port in California, as well as more than 600 businesses, 18 public parks, significant coastal marsh and wetlands, and home to more than 89 species of fish and an estimated 300 species of birds. Completed in early 2012, the Sea Level Rise Adaptation Strategy for San Diego Bay is one of the nation's first regional approaches to preparing for projected sea level rise and building the resilience of the economic, environmental, and community resources around San Diego Bay. Completed in 2012, the strategy consists of two main components: a comprehensive vulnerability assessment that evaluates how community assets could be impacted by sea level rise, and 10 broad recommendations. The report is the result of a year-long collaborative process which engaged major stakeholders around the Bay, and was led by ICLEI-Local Governments for Sustainability, and a steering committee of representatives from the San Diego Airport, Port of San Diego and its five member cities. Funded by a grant from The San Diego Foundation, the strategy is a foundation to guide coordinated adaptation planning among participating local jurisdictions, and align with other sea level planning efforts in the region such as Climate Understanding & Resilience in the River Valley underway near the US-Mexico border. This presentation will explore key findings, opportunities and challenges associated with the strategy and its implementation in the context of broader climate impacts research and climate adaptation actions in the San Diego region.

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EFFECTS OF SHORELINE ARMORING ON BEACH WRACK SUBSIDIES TO THE NEARSHORE ECOTONE

The ecological significance of algal and seagrass wrack subsidies to exposed-coast sandy beaches has been well-documented. In marine nearshore ecosystems where beaches are fringed with riparian vegetation, the potential for reciprocal subsidies between marine and terrestrial ecosystems exists, but is relatively unstudied especially in mixed-sediment beaches. Within the marine-terrestrial ecotone, upper intertidal "wrack zones" accumulate organic debris from algae, seagrass, and terrestrial plant sources and provide food and habitat for many organisms. Human modification also occurs within this ecotone, particularly in the form of armoring structures for bank stabilization that physically disrupt the connectivity between marine and terrestrial ecosystems. We conducted detailed wrack and log surveys in spring and fall over 3 years at 29 armored-unarmored beach pairs in Puget Sound, WA, USA. Armoring lowered the elevation of the interface between marine and terrestrial ecosystems, and armored beaches had less wrack overall and a lower proportion of terrestrial plant material in the wrack. Marine riparian zones were an important source of wrack to unarmored beaches, but their inputs were greatly reduced on armored beaches. Armored beaches also had far fewer logs in this transition zone. Thus, they lacked biogenic habitat provided by logs and riparian wrack as well as the organic input used by wrack consumers. Results such as these that demonstrate armoring-associated loss of connectivity across the marine-terrestrial ecotone may be useful in informing conservation, restoration, and management actions.

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EXAMINING THE RESPONSE OF DENITRIFICATION TO NUTRIENT ENRICHMENT OVER AN ANNUAL CYCLE IN NEW ENGLAND SALT MARSHES

There is much interest in understanding the potential for salt marshes to remove some of the anthropogenic nitrogen flowing into coastal systems via denitrification. We measured denitrification using the isotope pairing technique (IPT) in sediment cores taken from two marshes located at the extremes of the nutrient concentration gradient in Narragansett Bay, Rhode Island. We measured ambient denitrification rates and total denitrification capacity on a monthly basis during the spring, summer, and fall for one year. By using IPT, we were able to distinguish between rates of direct denitrification of nitrate in the tidal water versus coupled nitrification-denitrification of nitrate produced within the sediment. We found that total capacity and ambient denitrification rates were significantly higher at the marsh with a higher nitrogen (N) load, due to differences in direct denitrification as opposed to coupled. The maximum differences between the marshes generally occurred during early fall, which was also the time of the year with highest water column nitrate values. In addition, seasonal nitrate availability in the tidal water corresponded with seasonal changes in direct denitrification. Both marshes exhibited similar rates of coupled nitrification-denitrification and sediment oxygen uptake, indicating similar availability of labile organic carbon. We also found that total denitrification capacity was higher than ambient denitrification, often by an order of magnitude, indicating that denitrifiers at both sites are nitrate-limited. We conclude that the differences in denitrification activity between sites was likely driven by differences in nitrate availability in the tidal water, as opposed to carbon availability in the sediments.

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EFFECTS OF ANTHROPOGENIC SHORELINE HARDENING AND WATERSHED LAND USE ON CONDITION INDICES OF THREE FISH SPECIES

Direct and indirect loss of estuarine communities has been a result of a combination of natural and anthropogenic stressors, making nearshore marine environments some of the most threatened habitats. Continued land use changes in Chesapeake Bay watersheds have led to decreased water quality and seasonal algal blooms in shallow-water regions. This study examined the impact of watershed land use and shoreline habitat alteration on species-specific condition indices of ecologically or economically important fish species in the Chesapeake Bay (*Fundulus heteroclitus*, *Menidia menidia*, and *Morone americana*). We sampled 12 subestuaries between 2010 and 2013 spanning a gradient of land use categories and focused on four shoreline types: two natural (beach, marsh) and two altered (riprap, bulkhead). Generalized linear models were used to assess two condition indices (hepatosomatic index and relative weight condition) across subestuaries and shoreline types. *F. heteroclitus* were marsh-specific, with male weight condition being larger than female, while females had a better hepatosomatic index than males. Relative weight condition for *M. menidia* was significantly greater at beach and altered riprap habitats compared to marsh habitat. Hepatosomatic index in *M. menidia* improved as the percentage of forest increased within the watershed. Increased cropland and developed land in the watershed were associated with a decrease in hepatosomatic index in *M. americana*. With important species showing shoreline habitat and land use effects on condition indices, these findings suggest that replacement of natural shorelines with hardened structures and ongoing land use changes could decrease the quality and abundance of critical nearshore shallow-water habitats and alter estuarine community dynamics. These findings have significant implications for resource and water quality management in the Chesapeake Bay.

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EFFECTS OF ZOOPLANKTIVORES WITH VARYING FEEDING STRATEGIES ON THE STRUCTURE AND DIVERSITY OF LITTORAL ZOOPLANKTON COMMUNITIES: THE ADAPTIVE FOOD WEB HYPOTHESIS APPROACH

The aim of this study was to investigate the effects of two key fish species on littoral zooplankton prey assemblages in a Baltic Sea coastal area. Feeding patterns of fish in the unique brackish Baltic Sea have been studied previously mostly in open sea pelagic zones, and very little is known about interactions of fish and zooplankton communities inhabiting the shallow littoral waters in the Finnish coastal area, where rapidly rising seawater temperature is potentially affecting both fish and plankton community structure. The two key zooplanktivores that were chosen utilize different feeding strategies: the marine three-spined stickleback Gasterosteus aculeatus (L.) is a vision-oriented selective particulate feeder, while the juvenile roach Rutilus rutilus (L.) is mainly a schooling non-selective filter feeder. We experimentally studied effects of these varying strategies using small-scale in situ enclosures with natural zooplankton communities. Preliminary results indicate compelling differences in zooplankton abundance, biomass, functional diversity, and species composition and richness depending on zooplanktivore presence and type. Results are examined with reference to the adaptive food web hypothesis (Kondoh, 2003).

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QUANTIFYING THE EFFECTS OF NITROGEN AVAILABILITY ON NITRIFICATION, CARBON RESPIRATION, AND THEIR INTERACTIONS IN THE COASTAL OCEAN

Nitrogen (N) transported through the atmosphere and deposited to the ocean now equals the flux of N arriving in rivers, and is projected to increase 70% by the year 2100. Yet in spite of the large and increasing quantities of N that are deposited to the sea surface, we have a limited understanding of the effects of N deposition on important marine biogeochemical processes—especially processes other than photosynthesis. We determined the effects of N deposition on rates of ammonia oxidation and C respiration off the coast of northern California (Bodega Canyon) via time series measurements and experimental manipulations. We used ^{15}N-labeled NH_4^+ to measure ammonia oxidation rates and oxygen consumption to calculate C respiration throughout spring, summer, and fall of 2013, when upwelling and overall nutrient availability vary dramatically. Variations in rates, with depth and among sampling events, were explored and related to key environmental variables, including nutrient concentrations and temperature. We used quantitative PCR together with the rate measurements to quantify the abundance of involved microbial groups, such as ammonia oxidizing *Archaea* and *Bacteria*, SAR11 and SAR86. During select sampling events, factorial experiments were conducted to directly examine the effects of N additions on ammonia oxidation and C respiration rates. Assembled together, these data provide new insight into the biogeochemical coupling between marine nitrification and respiration, and possible interactions with photosynthesis.

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SENTINEL SITES: A NATIONAL NETWORK TO MONITOR SEA-LEVEL IMPACTS

Over the recent past, a number of different agencies and institutions have developed somewhat similar, often compatible programs based on the concept of providing needed data on coastal sustainability and vulnerability to flooding and inundation from rising sea levels. Information needs are addressed through monitoring long term changes in local water levels and associated physical characteristics and ecological processes, biological resources, and even cultural assets. This talk will introduce the broad "sentinel site" concept, and highlight a wide range of examples from a growing number of adherents. The backbone of the concept is the colocation of robust, long term observation infrastructure connected vertically though high accuracy positional control networks with documented stability. Since sea level change and associated responses are locally determined, all data streams must be locally defined, and vertical changes expressed with respect to consistent vertical datums. This colocation of observations has led to the need to develop new techniques to connect a wide range of data collection platforms through the application of high precision surveying. Subsequently, the challenge remains to involve scientists, coastal resource managers and stakeholders in the process of developing data-driven products and tools to tto support decision making with locally derived high value information on sustainability and risks in the face of changing local water levels. Here in the United States, programs have been initiated to develop networks of sentinel sites to provide national coverage. The session will include representation from a variety of agencies and institutions which have built on this concept to develop regional, national, and even global networks. In addition, talks will focus on specific examples of how sentinel site data are being used to inform scientists, resource managers, local planning and coastal decision-makers.

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SHADING MAY REDUCE BLEACHING OF CORALS THRIVING IN A MANGROVE ECOSYSTEM

Coral bleaching is a stress response that occurs when symbiotic algae become dissociated from coral hosts. It can be caused by exposure to high seawater temperatures and high irradiance levels from sunlight. Climate change is predicted to lead to more severe bleaching events as seawater temperatures increase. Effects of coral bleaching were studied

in Hurricane Hole, a mangrove ecosystem that consists of three bays within the marine protected area Virgin Islands Coral Reef National Monument, St. John, US Virgin Islands. A high abundance and diversity of scleractinian corals have been observed within and adjacent to the prop roots of red mangroves (Rhizophora mangle) that grow around the perimeter of each bay and provide shade to some of the corals. The same coral species that inhabit Hurricane Hole suffered high mortality (60% loss of live cover) on the fringing reefs of St. John during a disease outbreak following a major-bleaching event in 2005. Another bleaching event occurred in St. John in the late Summer/Fall of 2010. Two abundant reef-building coral species, Diploria labyrinthiformis and Colpophyllia natans, were monitored in Hurricane Hole during and after the event, and classified as either bleached or non-bleached and shaded or unshaded. Coral colonies from different locations and their recovery from bleaching were compared. Results include the following: (1) D. labyrinthiformis bleached more than C. natans, (2) Shading reduced the bleaching of D. labyrinthiformis, (3) Colonies of D. labyrinthiformis that were initially bleached, recovered with low mortality, (4) More days with temperatures exceeding the bleaching threshold at 30°C or higher occurred in 2010 than in 2011 and 2012, when bleaching was not observed. These results suggest that different reef-building coral species may respond differently to climate change and that local environmental factors such as shading may reduce thermal stress.

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CHARACTERIZATION OF SHORT-TERM NITROGEN SOURCES FOR SEAGRASSES AND MACROALGAE IN A LAGOON SUBJECT TO COASTAL UPWELLING EVENTS BASED ON STABLE ISOTOPES OF NITROGEN

San Quintin Bay (SQB) is a hypersaline lagoon located in the Pacific off Baja California, Mexico. Intense upwelling near its mouth during spring and early summer leads to pumping of high concentrations of nitrate into the bay, particularly during spring tides. Freshwater inflow and nitrogen inputs from nearby agriculture are negligible. Previous studies indicate nitrogen fixation may play an important role as an N source for benthic primary producers. Nitrogen isotope ratios (δ15N) of seagrasses and macroalgae serve as natural tracers of nitrogen sources. We used the δ15N values of Zostera marina and Ulva spp as proxies to evaluate the relative importance of upwelled vs. fixed nitrogen during upwelling and non-upwelling conditions. Following the upwelling events that usually last a few days, the δ15N values of young leaves of Z. marina and Ulva spp. should reflect upwelled nitrate (8-10‰). During non-upwelling conditions, when nitrogen is limiting, δ15N values should reflect the assimilation of fixed nitrogen (0‰). We measured the δ15N values of nitrate and plant tissues collected at 11 sites throughout the bay every two weeks between March and June 2013. Two manipulative experiments were performed to determine whether algal samples from a given site reflected the isotopic composition of the local nitrate pool. Samples collected at each site were placed in mesh bags and resampled after two weeks. Algae collected from a single location were transplanted to different sites, placed in mesh bags and resampled after a two-week incubation. The natural and experimental algal samples should exhibit similar isotopic values if the isotopic composition of the plant tissue reflects recently assimilated nitrogen and there is limited algal drift. We will use a two-source mixing model to quantify the relative importance of nitrogen transported into the bay vs. fixed nitrogen under upwelling and non-upwelling conditions and as a function of distance from the mouth.

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ATTAINING WATER QUALITY STANDARDS IN THE CHESAPEAKE BAY AND ITS TIDAL TRIBUTARIES: A SHOWCASE FOR ADAPTIVE MANAGEMENT

Assessing the estuarine response to Chesapeake Bay load reductions is a key component of the accountability framework within the Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment (TMDL), which draws on the principles of adaptive management. The Chesapeake Bay Program (CBP) Partnership is currently working towards 60% achievement of the Bay and its tidal tributaries' water quality standards (WQS) for dissolved oxygen, underwater bay grass/water clarity and chlorophyll a by 2025 by implementing 100% of the pollution reduction actions no later than 2025. We developed an area-weighted integrated indicator to measure progress towards the attainment of the four tidal jurisdictions' Chesapeake Bay WQS; the 2008-2010 baseline indicates 40% attainment. Time series analyses of criteria attainment using the developed indicator were conducted from 1985-2011 to evaluate the long-term trends of WQS attainment, which indicate a slow upward trend through time. Continued analyses of 1) the underlying 25-year history of indicator assessment data; and 2) existing Chesapeake Bay water quality sediment transport model (WQSTM) scenario results, will feed into the growing evidence necessary to make informed adjustments to current management efforts to ensure our goals are achieved. Furthermore, this indicator may also be incorporated into the ongoing efforts to understand the underlying reasons for Bay criteria attainment patterns over time and be a useful tool in evaluating the actual reductions likely to be observed to the Bay, while accounting for lag times as evident from the 25-year record of monitoring data.

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MEIOFAUNA COMMUNITY RESPONSE TO LOW OXYGEN CONCENTRATION ALONG THE SAN DIEGO MARGIN

Oxygen Minimum Zones (OMZs) represent an extreme condition among ocean environments. The continental margin of the eastern Pacific harbors the single largest oxygen minimum zone (OMZ, O2 < 0.5 ml L-1) in the world. In contrast to the coastal areas that typically experience only episodic or seasonal hypoxia, continental margins intercepted by OMZs are permanently hypoxic in the deep sublittoral to bathyal benthic environment, creating strong gradients of bottom-water oxygen concentrations and organic matter input. Current data suggests OMZs are expanding, with potential changes in the structure and function of marine ecosystems. This study investigates the roles of oxygen and organic matter on meiofaunal community structure on an upwelling margin off San Diego, California. We examine meiofaunal samples collected during the San Diego Coastal Expedition (June 30-July 10, 2012 and December 10-December 20, 2012) at 6 stations ranging between 300 to 1200 m depth, crossing the OMZ located between 500 and 1000 depth. Here we describe the community composition, numerical abundance and biodiversity of gross meiofaunal taxa in relation to key environmental variables, as well as any observable temporal changes in the community. Preliminary results revealed that within the OMZ core (700-800 m) higher taxa diversity is reduced. Also, in contrast to other nearby oxygenated sites or other OMZ settings of the eastern Pacific OMZ, where the hypoxic conditions are more intense, unexpectedly low nematode and relatively high copepod densities within the OMZ core (~0.2 ml L-1), were found. This suggests that the relatively higher bottom oxygen threshold at the San Diego margin may intensify predation on nematodes. Information on local meiofauna at the community level and dominant faunal groups such as nematodes will contribute to a better understanding of the influence of hypoxia thresholds and habitat heterogeneity and marine biodiversity.

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OCEAN ACIDIFICATION STUDY IN A MEDITERRANEAN OYSTER CULTURE COASTAL LAGOON DURING TWO CONTRASTING UPWELLING CONDITIONS IN BAJA CALIFORNIA MéXICO

San Quintin Bay (SQB), is a hypersaline coastal lagoon where water from the California Current System (CCS) is the principal external forcing of biogeochemical processes. However, CCS is expected to experience ecological impacts of ocean acidification (OA) because coastal upwelling brings old CO2 rich water to surface ocean. The objective of this work, was study the effect of ocean acidification during two dissimilar upwelling seasons, and to understand the subsequent biogeochemical changes. Measurements of Dissolved Inorganic Carbon (DIC), Total Alkalinity (TA), salinity and temperature in surface water were carried out during spring-summer 2004 and 2005. In addition, pH and saturation states of the aragonite (Ωarg) were estimated using DIC-TA. Samplings were carried out during spring tides whiting in the main channels ten (2004) and twelve times (2005). Different scenarios were observed on the distributions of pH, dissolved inorganic carbon (DIC) and saturation states along the bay, resulting from different combinations of upwelling intensity and tidal amplitude. During spring 2004 close shelf stations, DIC, pH and Ωarg showed values mainly lower than 2100 μmol/kg, pH between ~7.75-7.95 and Ωarg. Whereas in spring 2005, more intensive upwelling conditions were observed, DIC was higher and varied from 2100-2200 μmol/kg but TA was also higher (~70 μmol). In addition, we apply an empirical relationship model described by Simone et al., (2012), for estimating the carbonate system in one transect from the IMECOCAL program (Investigaciones Mexicanas de la Corriente de California), in order to reconstruct pH, DIC and Ωarg and to assess ocean

forcing differences during spring 2004 and 2005 out of the bay. The result indicates that DIC supply from the ocean to BSQ during upwelling is a very strong CCS related.

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ISOTOPIC EVIDENCE OF NITROGEN FIXATION IN PRIMARY PRODUCERS IN SAN QUINTIN BAY, MEXICO: A SEASONAL COMPARISON

San Quintin Bay (SQB), Baja California, is a shallow and seagrass dominated coastal lagoon influenced by the California Current System. Due to the lack of continental supply of materials to SQB, upwelling in the adjacent ocean plays an essential roll in the seasonal variability and distribution of dissolved inorganic nitrogen within the lagoon. Previous studies indicate that nitrogen limits primary production in SQB and that probably denitrification exceeds nitrogen fixation at the ecosystem level. However, unpublished $\delta^{15}N$ measurements in *Zostera marina* leaves suggest that at innermost zones, during the upwelling season (spring-early summer) nitrogen fixation could predominate over denitrification. It is therefore possible that eelgrass meadows in SQB are an important source of new nitrogen via N fixation, with its importance increasing towards late summer when the supply of new nitrogen from coastal upwelling is low or absent. Samples of *Z. marina* shoots and *Ulva* spp. fronds are collected monthly since February 2013 for $\delta^{15}N$ and $\delta^{13}C$ analyses at stations that follow a gradient of decreasing oceanic influence. The third youngest leaf of each *Z. marina* shoot will be analyzed based on the premise that this tissue integrates a period of around 20-25 days, and can be use to evaluated seasonal differences in N sources. In contrast, the isotopic signal of faster-growing *Ulva* spp. fronds should integrate a period in the order of a few days, which reflects more immediate oceanographic conditions. We expect to find a spatial and seasonal variation in the isotopic composition of primary producers, with the lowest $\delta^{15}N$ values at the innermost stations and in late summer, reflecting a higher supply of N from N fixation.

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HARMFUL ALGAL BLOOMS IN THE NORTHERN YUCATAN PENINSULA

Yucatan waters are characterized by the upwelling of the Yucatan Channel, SE Gulf of Mexico, groundwater discharges resulting in nutrient enrichment, and extensive coverage by submerged aquatic vegetation (SAV), that make harmful algal blooms (HABs) more frequent and intensive, covering vast areas and lasting longer. HABs have been reported since the 1940s, recently being more evident in 2001, 2003, 2008 and 2011, with noticeable ecological and socio-economic impacts. The Laboratory of Primary Production in CINVESTAV-IPN (Merida, Mexico) implemented a HABs and water quality monitoring program in 14 ports/marinas of the northern Yucatan Peninsula (from Chuburna eastward to Dzilam de Bravo. Quantitative phytoplankton samples were analyzed using the Utermöhl technique, and benthic/epiphytic dinoflagellates were counted in a Sedgwick-Rafter chamber. Fourteen noxious phytoplankton species were found, of which the diatoms Nitzschia reversa (up to 2.00x107 cells/l) and Cylindrotheca closterium (up to 1.11x107 cells/l) in coastal waters and the dinoflagellate Scrippsiella trochoidea (up to 3.94x107 cells/l) in offshore areas were the most frequent and abundant in the period from 2001 to 2011. Furthermore, 26 benthic/epiphytic dinoflagellate species were identified, Prorocentrum rhathymum being the most abundant and common (up to 7.28x104 cells/g substrate wet weight). In 2011, the HAB event was multispecies and long-lasting (about 150 days), reaching abundancies of >106 cells/l and resulting in the total loss of SAV and in fish and benthic invertebrate mass mortalities. The HABs along the northern Yucatan Peninsula were shown to be dynamic and multifactorial, with spatial variations both parallel (east-west) and perpendicular to the coast (north-south) and also site depth dependent.

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CLIMATE-CHANGE SIMULATIONS WITH HSPF PHASE 5.3.0 MODEL OF THE CHESAPEAKE BAY WATERSHED

The objective of this study was to assess how future climate change will affect stream flow, nutrients, and sediment in the Chesapeake Bay watershed. We conducted six 10-year simulations of the Chesapeake Bay watershed model for the last decade of the 21st century, where mean annual cycles in air temperature and precipitation forcing were altered according to the projections of six General Circulation Models (GCMs) for the A2 scenario form the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emission Scenarios (SRES). On a bay-wide basis, all considered GCMs projected warming in every season, with the average annual temperature increase of 4.0 ± 0.3 °C (mean ± standard error of the mean for the six GCMs). Projected precipitation changes varied considerably in sign and magnitude on the annual basis, but most GCMs suggested an increase in winter (8 ± 6%) and spring (8 ± 5%) precipitation. Simulated stream flow decreased in all seasons for most model runs. Annually, all but one model run produced a substantial decrease in stream flow, with the mean decrease of 0.11 ± 0.05 m yr-1 relative to a historic baseline of 0.5 m yr-1. Anomalies in simulated nitrogen, phosphorus, and sediment fluxes did not show a consistent pattern among the six runs. Seasonal and annual changes were on the order of ± 20% for nitrogen, ± 50% for phosphorus, and ± 100% for sediment. Averaged over the six runs, annual anomalies were slightly negative for nitrogen (-0.1 ± 0.3 kg s-1 relative to a baseline of 5 kg s-1) and phosphorus (-0.02 ± 0.04 kg s-1 relative to a baseline of 0.29 kg s-1), and positive for the sediment load (32 ± 45 kg s-1 relative to a baseline of 137 kg s-1). Our results suggest that projected climate change will likely lead to a substantial decrease in stream flow but the impacts on nutrient and sediment loads are difficult to quantify, mostly because of large disagreement among the GCMs in projected precipitation changes for the watershed area.

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A META-ANALYSIS OF STABLE ISOTOPE TURNOVER RATES IN FISHES IN THE CONTEXT OF CONNECTIVITY AND MIGRATION STUDIES

Connectivity and migration have important consequences for the population structure and dynamics of marine fish populations. Stable isotope ratios (SIR's) of soft tissues may serve as tracers of connectivity and migration of individuals, particularly for species that transition between habitat types during their life cycle or that can select among multiple alternative habitats. The application of SIR's relies on accurate estimates of isotope turnover rates. Turnover rates delimit the window of opportunity for linking a particular isotopic signal with a specific habitat type and for distinguishing between residents and immigrants. Knowledge of isotope turnover rates are also required for estimating the size at which an individual migrated and the time that has elapsed since a habitat shift. There are only a limited number of controlled studies that report carbon and nitrogen tissue-specific isotope turnover rates for finfish and elasmobranchs. This compromises the interpretation of SIR's of fish soft tissues, and renders them qualitative. We review the application of SIR's to the study of connectivity and migration between estuarine and coastal habitats, and evaluate whether published studies meet the premises and requirements for the interpretation of isotopic data. In particular, we carry out a meta-analysis to examine the relative contribution of growth and metabolic turnover to isotopic turnover as a function of life stage, size, growth rate, swimming behavior, metabolic rate (endothermic vs. ectothermic) and temperature. Based on these results, we suggest more accurate procedures for estimating isotope turnover rates in studies where direct measurements are not available. This work enhances the utilization of SIR's to studies of fish habitat use, connectivity and migration.

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PREPARING CALIFORNIA'S CITIES FOR CHANGES ON THE COASTLINE

Sea-level rise is a daunting challenge for major coastal cities, which have dense and vulnerable resources, are crucial to regional and national economies, and typically operate under complex and politicized coastal governance structures. As primary land use decisionmakers, cities will make adaptation choices that affect both private development and critical municipal infrastructure such as roads, power plants, and ports. Regulation of coastal development in California has already been controversial for decades. Sea-level rise and the possibility of increased storm surges will present new and more complex challenges. Accordingly, we will discuss various governance, legal, and policy issues facing major California cities as they plan for the impacts of sea-level rise, and present a set of tools these cities could use to build resilience in advance of a West coast Sandy-scale disaster or more gradual, inevitable change. We view California's large cities' resilience to sea-level rise and storm surges through the lens of a three-part adaptation framework that helps governments, property owners, and other stakeholders to understand the consequences of their decisions and to plan accordingly. First, cities can choose to attempt to protect properties and infrastructure in their current configuration. Second, they may decide to use regulatory tools to channel and reshape development in a way that limits the conflict between land use and changing shoreline dynamics. And third, they may facilitate retreat from the shoreline in order to avoid even higher economic, ecological, or social costs. We will discuss ways that California cities can—or cannot—employ a combination of these three strategies within California's legal and political context. California cities' experience may be valuable for other U.S. cities because of the influence that the state often has in shaping other jurisdictions' policies.

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EELGRASS RESILIENCE TO THE DIRECT AND INDIRECT EFFECTS OF EUTROPHICATION: UPWELLING-INFLUENCED NUTRIENT DELIVERY AND HYDRODYNAMICS

In upwelling-influenced estuaries, observational studies suggest that temporal patterns in eelgrass (Zostera marina L.) are not negatively associated with marine-derived nutrient loading or blooms of ulvoid macroalgae. This contradicts trends from other estuaries, which show negative effects of these nutrient pathways on seagrass. We conducted two experiments, which contrasted in hydrodynamic environment, to determine the mechanisms affecting eelgrass resiliency. We manipulated nutrients and macroalgae in a factorial design to determine the strength of evidence for individual and interactive affects of these nutrient pathways. In the field, we found little evidence that nutrients and/or macroalgal treatments affected measures of eelgrass productivity. In the mesocosm experiments, however, evidence strongly supported an interactive effect of both treatments, leading to eelgrass declines. Hydrodynamic differences between experimental settings in rates of water movement and degree of submersion likely mitigated the mechanisms operating in the mesocosms, allowing for eelgrass persistence under high nutrient loading and macroalgal biomass. In the mesocosms, negative effects were associated with increased light attenuation and decreased sediment oxygen levels. The additive effect of these two factors was associated with larger effects on eelgrass than shading alone, which was evaluated using mimic algae treatments. A direct effect of nutrient addition on seagrass density and biomass was also found in the mesocosms, but it was not as pronounced as the macroalgal effects. These results demonstrate that in order to manage critical seagrass habitats and address threshold limits for nutrient criteria and macroalgal indicators, consideration of local hydrodynamic environment and marine-based nutrient delivery is essential.

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EFFECT OF TS LEE AND HURRICANE ISAAC ON SALTMARSH TERRESTRIAL ARTHROPODS

Saltmarshes that fringe the Gulf of Mexico typically experience <50cm in tidal change with salinity ranges from 8-12ppt. Storm surge from tropical storms and hurricanes inundate these marshes with several meters of high-salinity seawater for 30 to 70 hours. Insects and spiders make up an important part of the saltmarsh food web as food for frogs, fish and birds. We collected insects and spiders that inhabit the interior of the stems of Spartina alterniflora and those that live outside the stems on the upper 2/3 of the stems. We sampled marshes in Barataria Bay and Breton Sound within two days before Hurricanes Alex (June 2010) and Isaac (August 2012), tropical storms Bonnie (July 2010), Lee (Sept 2011), and Debby (June 2012). We also sampled the same areas within a week of each of these storms passing. After Hurricane Isaac, we sampled weekly using sweep-net sampling for 10 weeks. Our data indicate that insects and spiders, while impacted, are capable of withstanding ~30h of storm surge inundation. The surge from Isaac lasted >60h and radically suppressed coastal arthropods. Hurricane Isaac allowed us to assemble data on insect and spider succession in Spartina saltmarshes. More than 100 species of insects inhabit the marsh. Spiders, katydids, leafhoppers, and seed bugs were reduced by more than 10-fold by tropical storm Lee storm surge. One of the species we specifically track is Crematogaster pilosa, the acrobat ant that nests within hollow stems of the Spartina alterniflora. After tropical storm Lee, the ants were largely unaffected indicating that the nests can survive >30h inundation. However, after hurricane Isaac, the numbers of ants collected was reduced 10-fold. More than 90% of the colonies that we marked in June and July of 2012 were lost during hurricane Isaac. There were colonies that survived the inundation of Isaac's >62h surge, and we are exploring the mechanism of survival.

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ARMS: ASSESSING GLOBAL MICROBIAL DIVERSITY THROUGH STANDARDIZED SAMPLING

Questions surrounding the drivers of biodiversity have been on the minds of ecologists for years, however with new emerging technologies these questions are becoming more approachable. Autonomous Reef Monitoring Structures, or ARMS for short, have provided an avenue for ecologists to assess biodiversity of coral reefs at many sites worldwide. These standardized structures are layered settlement plates which provide a surface for communities of species living on the reef to reside. These structures can be routinely collected and compared across many spatial and temporal scales with a common degree of settlement substrate. Microbes that live in association with the macro organism settling on these plates are of increasing interest and as sequencing technologies become more and more accessible the investigation of whole communities independent of culturing is possible. The standardized format of the ARMS system provides a means to study the complexity of microbial-macrobial relationships over space and time and builds a foundation for answering big questions about biological diversity in a global context.

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INSIGHTS INTO VEGETATION COLONIZATION AND EXPANSION DYNAMICS AT A TIDAL FRESHWATER RESTORATION SITE IN THE SACRAMENTO/SAN JOAQUIN DELTA, CALIFORNIA

Understanding plant colonization and expansion dynamics is an essential component in the development of sustainable restoration plans. We conducted both observational and manipulative studies at the Liberty Island tidal freshwater tule marsh restoration site in the Sacramento/San Joaquin Delta, CA that focused on vegetation dynamics at the site, particularly *Schoenoplectus californicus*. Our approach had multiple components, including: 1) seed bank assay, 2) field transplant study of *S. californicus*, *S. acutus*, and *Typha latifolia*, 3) field transect study, and 4) vegetation lateral expansion study at multiple locations. The seed bank at the site displayed a greater species richness of viable seeds than is currently present in the emergent wetland plant community, suggesting that environmental conditions limit the successful germination and persistence of many of these species. Transplant establishment success was greatest with adult transplants (versus rhizomes), likely because of greater flooding stress, and although all three species assessed were able to establish, *S. californicus* displayed the highest transplant survivorship and rapidly became the dominant species and exhibited high rates of vegetative expansion. The transect study (*S. californicus* dominated) revealed interesting differences between locations at Liberty Island that displayed a range of soil conditions, marsh platform and marsh edge elevations, as well as variable rates of lateral expansion. Previous site history in combination with current hydrologic and exposure gradients appear to be exerting considerable modulation of the plant community dynamics. Our findings illustrate the importance of recognizing multiple factors and dynamic interactions between the plant community and the abiotic environment when considering restoration thresholds.

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WIND AND TIDAL MODULATION OF DENSITY-DRIVEN CIRCULATION IN AN INVERSE ESTUARY

In Shark Bay, Western Australia the arid climate and the general absence of river input causes a persistent state of hypersalinity in the inner regions, leading to its classification as a 'negative', or inverse estuary. Recent field measurements of velocity and stratification in Shark Bay showed intermittent stratification and near bed outflows of varying intensity at the two main entrances, indicating that density-driven exchange flow is common during the winter. The bottom outflows were enhanced during periods of low tidal mixing. There was also evidence that strong wind events could break down the two-layer structure. The present study used a three-dimensional baroclinic ocean circulation model (the General Estuarine Transport Model, GETM) to investigate the role of wind and tidal mixing for regulating vertical stratification and the strength of the outflow in Shark Bay. Results indicated that the relative contributions of wind and tidal mixing energy for controlling the vertical stratification were of similar magnitude. In the shallow regions (< 15 m) either wind or tide could fully mix the water column. In contrast, a combination of both wind and tide was required to mix the deeper channels (> 15 m). These results agreed with the field measurements and supported the view that the dense water outflow through the deeper northern channel was more persistent than in the western channel and represented the main pathway for export of water from Shark Bay.

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VERTICAL DISTRIBUTION OF DISSOLVED OXYGEN IN THE RUSSIAN RIVER ESTUARY DURING PERIODS OF INLET CLOSURE

During periods of inlet closure, the dissolved oxygen field was investigated for the Russian River estuary, a bar-built, drowned-river-valley estuary located in northern California. Similar to other estuaries situated in Mediterranean climates, the inlet to the Russian River estuary experiences episodic closure. The occurrence probability of inlet closure is highest during the months of May through November when the river flow is lower than normal, which allows sediment deposited by wave-driven processes to build a sand bar at the estuary mouth. Separation from the ocean and the mixing effect of the tides, allows intense vertical stratification to develop within the estuary, which impacts water properties. Of particular concern are the low or zero dissolved oxygen concentrations observed in bottom water during prolonged inlet closures. Using seasonal field data from the Russian River estuary, collected during closures over 3 years, the vertical distribution of dissolved oxygen during periods of inlet closure is described and examined using a vertical 1-dimensional model. Through this model, oxygen demand in the water column is quantified during periods of full inlet closure.

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IMPLICATIONS OF TEMPORAL VARIATIONS IN FUNCTIONAL REDUNDANCY, AND INTERACTIONS BETWEEN FUNCTIONS, TO RESILIENCE

Functional redundancy is a critical factor in determining resilience of communities to stressors. Little is known about temporal fluctuations in redundancy, mainly due to the lack of relevant datasets, yet this will be critical in assessing resilience to climate change. We analyse 24 years of benthic macrofaunal data to determine patterns over time in the species comprising different functional traits from 2 sites in a large temperate harbour in New Zealand. These fluctuations are related to species richness, habitat heterogeneity and broad-scale climatic changes (i.e., El Nino Southern Oscillation). The interaction network derived from these data are compared to those from another long-term data set, benthic macrofauna over 40 years in the Finnish archipelago, and a shorter time series, 8 years, of macrofaunal data along the coastal Ross Sea, Antarctica.

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ENVIRONMENTAL AND ANTHROPOGENIC IMPACTS ON SURVIVAL OF JUVENILE WINTER FLOUNDER IN COASTAL LONG ISLAND, NY

In recent years populations of winter flounder (*Pseudopleuronectes americanus*) in Long Island have reached record low numbers, often hypothesized to be due to high rates of mortality in the first year of life. Our aim was to investigate biological, environmental, and anthropogenic effects influencing the survival of post-settlement juvenile winter flounder in Long Island bays. Samples were collected during bi-weekly beam trawl surveys from June to October 2010 in Jamaica Bay, Moriches Bay, Shinnecock Bay, Cold Spring Pond, and Napeague Harbor, and from May to October 2011 in Jamaica, Moriches, Shinnecock Bays. These sites have varying degrees of anthropogenic impacts with a corresponding west to east urban gradient with proximity to New York City. In addition a caging study was added in 2011 in Jamaica, Moriches, and Shinnecock Bays to assess the impact of predation and environmental conditions on mortality. Percent daily mortality ranged from 1.01-5.73 between the five sampling areas in 2010 and 2011. Long-term monitoring of environmental conditions in 2011 showed a strong connection between mortality and hypoxia in the field. Expression of vitellogenin, a gene often used as an indicator of exposure to estrogenic compounds, was higher in fish from urbanized bays. Additionally, condition indices such as muscle RNA/DNA ratios, Fulton's K, and hepatosomatic index (HSI) decline in fall, while expression of genes associated with glucose metabolism increase, suggesting compensatory responses to stressful conditions later in the season. Site-specific environmental and biological variables appear be correlated with health and survival indices. Our findings provide evidence that a combination of environmental and anthropogenic stressors are detrimentally impacting the health and survival of winter flounder in Long Island.

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EFFECTS OF SEDIMENT TYPE AND TANK SHAPE ON HORSESHOE CRAB GROWTH AND SURVIVAL IN CULTURE

To better understand factors affecting success of horseshoe crabs reared in culture, we measured the effects of two conditions, sediment type (natural or clean sand) and tank shape (rectangular or kreisel style), on growth and survival of juvenile horseshoe crabs (Limulus polyphemus). During the nine-week experiment, horseshoe crabs reared in natural sediment and/or in rectangular tanks had higher growth rates than crabs reared in kreisel style tanks with clean sand. Horseshoe crabs reared in natural sediment (in either tank type) also exhibited lower % mortality compared to crabs in clean sand. Hence, by the conclusion of the experiment, horseshoe crabs reared in kreisel style tanks with clean sand showed no growth and 100% mortality. To determine whether sediment type affected growth and survival by affecting nutrition, we measured N and C stable isotope ratios in horseshoe crab tissues compared to organic matter available in sediments and in gel diet fed to horseshoe crabs during the study period. Stable isotope ratios differed among treatments, demonstrating that sediment-derived organic matter made a significant contribution only to the diet of horseshoe crabs reared in natural sediments. Among crabs reared in clean sand, N stable isotope ratios were heavier than expected for consumption of gel diet alone. Enriched N stable isotope ratios, along with the lack of growth and poor survival, suggest crabs reared in clean sand, particularly in kreisel style tanks experienced starvation. Overall, results suggest that sediment type may contribute to horseshoe crab success in culture by providing a significant food source to juvenile crabs and may be more important to culture success than tank shape. Tank shape, however, had a secondary affect on growth and survival that merits further study.

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ENVIRONMENTAL EFFECTS OF OYSTER AQUACULTURE ON NUTRIENT DYNAMICS IN CHESAPEAKE BAY

Environmental effects of native Eastern oyster (*Crassostrea virginica*) raft aquaculture were examined at 2 commercial-scale sites (and within-tributary reference sites) in Chesapeake Bay: Spencer's Creek, VA, a protected low flow headwater, and St. Jerome Creek, MD, a high flow site. Sediment N_2 production under oysters, measured using ^{15}N isotope tracer and

N_2/Ar, was generally lower than or not significantly different from reference rates. Oyster biodeposition significantly impacted composition of the denitrifying community (assessed via *nosZ*) at both sites, and changes in the microbial consortium concurred with sediment BOD evidence (approximately 2x higher underneath oyster rafts). Sediment microbial genetic analyses supported N_2 production evidence that the area impacted by oyster aquaculture is limited to ~5 m. Bacterial abundance measures were site dependent and oyster biodeposition did not affect sediment nitrifier abundance (assessed via FISH), indicating that oyster aquaculture is not likely to enhance coupled nitrification-denitrification solely by increasing nitrifiers. Water column nutrients (TKN, NH_3-N, $NO_{2,3}$, NO_2, NO_3, Ortho-P, TP), Chl-α, DO, or TSS in the vicinity of oyster rafts did not differ significantly from reference sites, although NH_3-N levels were generally higher at oyster sites. The predominant species of nitrogen in interstitial water was NH_3-N ($NO_{2,3}$ was rarely detectable), observed at 10-100x water column and 0.2-0.5x sediment levels. Sediment TP and N (TKN, NH_3-N, NO_2, NO_3) values were 2-13x higher at Spencer's Creek oyster versus reference sites, but were not significantly different within St. Jerome Creek. The implications of water column, pore water, and sediment data are that the influence of floating-raft oyster cultivation is not uniform for all sites in the Bay, and that oyster biodeposits from high density aquaculture are rapidly ammonified, resulting in nutrient regeneration as opposed to burial or denitrification.

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COMMUNITY COMPOSITION AND ABUNDANCE OF BACTERIA INSIDE A PERMEABLE REACTIVE BARRIER DESIGNED TO ENHANCE NITRATE REMOVAL FROM GROUNDWATER THROUGH DENITRIFICATION

Permeable reactive barriers (PRBs) are woodchip barriers designed to increase denitrifying bacterial populations by providing an ample carbon source, which is typically limiting in groundwater systems. The PRBs intercept groundwater, and the bacteria remove excess nitrate in the water, nitrate that would otherwise lead to eutrophication of adjacent coastal estuaries. We measured nutrient concentrations in the barrier and in control regions adjacent to the barrier, which reveal that the barrier is effective at removing nitrate, but little is known about the denitrifying bacteria, or the byproducts of their metabolism, including whether they increase fluxes of nitrous oxide. The geochemical measurements also hints that the PRB supports a variety of microbes other than denitrifiers, but little is known about their community composition and abundance. We characterized the denitrifying bacterial community using the functional gene nirS, and total bacterial community structure using the 16S rDNA. Preliminary qPCR data show that nirS is more abundant in the barrier relative to a control site. The anoxic environment in the barrier also promotes a different community structure of the microbes as revealed by analysis of the16S rDNA sequences collected in the barrier compared to the control. This suggests that the conditions in the barrier, including higher organic matter concentrations and lower oxygen concentrations, promote a different microbial community than adjacent control sites.

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THE STATE OF FISH AND INVERTEBRATE ASSEMBLAGES IN THE SOUTH BAY SALT POND RESTORATION PROGRAM'S RESTORATION PONDS

The objective of this study was to monitor the spatial and temporal variability of fish species composition and relative abundance in newly restored salt ponds and adjacent slough habitats using boat based trawling (otter trawl), which samples the bottom of slough habitats up to 1-meter of depth. Bimonthly to monthly monitoring was conducted from July 2010 up through March 2013, at 2-3 sites in Alviso Slough, 3-6 sites in Coyote Creek, and 3 sites in A21, and A19 and in 1 site in A6. During this period we collected over 13,000 individual fish from 38 species. In addition we have counted over 120,000 invertebrates from over 40 identifiable taxa including rank scoring of 4 taxa (mysid shrimp, amphipods and isotopods) which are too numerous to count individually. For this summary we examined the seasonal variability of the 10 most abundant fish species and the most abundance invertebrates (mysid and Crangon shrimp). Distinct seasonal patterns fish assemblages were apparent with summer species assemblages comprised of juvenile Pacific staghorn sculpin, Northern anchovies and English sole, while the winter assemblage included Pacific herring, American shad and the State threatened longfin smelt. The mysid shrimp (comprised of several species) was in greatest rank abundance during the winter and into the early summer, while Crangon shrimp were abundance year round; however a clear pattern of recruitment of juveniles occurred during the spring-summer months. These patterns highlight the value of the Alviso Marsh system as a vital nursery area for several key species of the nearshore marine food web (Pacific herring and Northern anchovy) the estuarine food web (Pacific staghorn sculpin and Crangon shrimp) and winter feeding grounds for longfin smelt. This study also observed the greatest abundance of mysid shrimp in the estuary and documents the overall benefits of restoring former salt ponds to tidal marsh habitats.

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LINKING COASTAL INFORMATION SYSTEMS TO ENABLE DATA SHARING AND MULTIPLE FUTURE USE

The modern world of online systems means that it is no longer possible to know how data will be used. Data and information must be discoverable and self-describing to enable levels of use from general public to managers to researchers. This requires a move away from custom built information systems, which are generally disconnected and incompatible. The next evolution is creating the glue between these systems. Rather than developing bespoke information suites, projects such as eReefs, SEQuITOR and TERN are developing frameworks which will allow existing systems and services to be described, discovered and accessed in a consistent manner. The eReefs project is developing a model of distributed data nodes to integrate collections of marine and coastal data including ocean modelling, satellite remote sensing, time series monitoring data and other geospatial data from various organisations. The Data Provider Node model describes how to supplement existing information platforms with supporting services such as vocabulary, persistent identifier and provenance services. These create the glue by providing definable terminologies and unchanging links to data and information and allow end users to discover relationships between data products. Data nodes then expose data, metadata and other supporting information that any particular community, such as ocean acidification could integrate, add value to and then use for particular purposes such as integration into model workflows and visualisations. This then allows information to be delivered not only for the original need, but for any other need or community that may come along in the future. This approach will allow for the next generation of data discovery, integration and interoperability through value adding, rather than replacing, existing systems thereby helping government agencies, research institutions and other environmental organisations to realise the true benefits of their data.

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COMPARISON OF NITROGEN TRANSFORMATION RATES IN VEGETATED AND UN-VEGETATED MARINE SEDIMENTS OF ST. JOSEPH BAY, FL

Detailed understanding of the fate of anthropogenic nutrient inputs to seagrass systems requires quantification of metabolic pathways that govern system responses to eutrophication. Bacterial nitrogen (N) transformations in the sediments likely drive the fate of N in seagrass meadows, but N transformation rates within vegetated sediments rarely have been measured. To characterize these rates, intact sediment cores from vegetated (containing Thalassia testudinum) and un-vegetated sites in St. Joseph Bay, FL, were collected and incubated in a continuous flow system. ^{15}N-labeled NO_3^- and NH_4^+ were added to track the fate of N. Samples from the inflow and outflow of the core incubations were collected and analyzed for net O_2 and N_2 fluxes via membrane inlet mass spectrometry and nutrient fluxes. Sediment oxygen demand tended to be higher in vegetated sediments than un-vegetated sediments, but this difference was significant only in the presence of added $^{15}NH_4^+$. $^{15}NH_4^+$ additions in both vegetated and un-vegetated cores also provided no evidence of anammox (as $^{29}N_2$ production). Denitrification rates were not enhanced with added $^{15}NO_3^-$ substrate, suggesting that denitrifiers were either incapable of accelerating their metabolism and/or a tight coupling with nitrification. Simultaneous heterotrophic N fixation was not observed; thus, net $^{28}N_2$ fluxes in unamended cores represent the best estimate of ambient denitrification rates, which were significantly higher in un-vegetated ($x_{unveg} = 204 \pm 25$, $p < 0.05$) versus vegetated sediments ($x_{veg} = 89 \pm 7$). Dissimilatory nitrate reduction to ammonium produced significantly more NH_4^+ in vegetated sediments ($x_{veg} = 29 \pm 8$, $p < 0.0001$) than in un-vegetated sediments ($x_{unveg} = 9 \pm 4$). Coupled with lower denitrification rates in these sediments, these results suggest the potential for accumulation and recycling of NH_4^+ in vegetated sediments.

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USING STABLE ISOTOPES TO ESTIMATE HABITAT-BASED RISK OF CONTAMINANT EXPOSURE IN FISH

Sediment contamination is a common threat to sustainability in coastal ecosystems. For fish, the risk of exposure to contaminants will vary with respect to life history, including movements between contaminated inshore and less impacted offshore areas, trophic

level, and habitat use. Stable isotopes can provide information on all these aspects of fish life history. The objectives of our study were 1) to determine the prevalence of microscopically-verified skin and liver tumors throughout a coastal tributary impacted by legacy contaminants, and 2) to evaluate fish tumor risk in terms of habitat usage as indicated by carbon (C) nitrogen (N) stable isotope analysis. Our case study was conducted in the St. Louis River, the largest U.S. tributary to Lake Superior and the largest "freshwater estuary" in the Great Lakes. The estuary has a mix of historical and current industrial impacts. We studied white sucker (*Catostomus commersoni*); they have been widely used as an indicator species for contaminant effects monitoring and are abundant and widespread within the St. Louis River. Skin and liver neoplasms both were present in 4.5% of breeding adult white sucker. The stable isotope data revealed that most white sucker were resident in the river and only a few were migrating to Lake Superior. Based on logistic regression, habitat usage was a significant predictor of tumor incidence. Further, a similar habitat use pattern was observed among fish with skin or liver tumors. Fish that obtained more than half their diet from the most polluted portion of the estuary had a risk of tumor incidence about twice as high as fish that fed elsewhere. We conclude that the stable isotope analysis was useful for identifying a sub-group of white sucker with a high risk of tumor incidence.

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DO SUMMER BLOOMS OF *THAUMARCHAEOTA* CONTROL DIN DYNAMICS OF SOUTHEASTERN SALT MARSH ESTUARIES?

We have monitored the population dynamics of Ammonia Oxidizing Archaea (AOA, Thaumarchaeota), Ammonia Oxidizing Bacteria (AOB) and Nitrite Oxidizing Bacteria (NOB) since 2008 at Marsh Landing, Sapelo Island, Georgia; initially quarterly then at weekly intervals. AOA population dynamics are characterized by pronounced mid-summer blooms (>1,000-fold increases in abundance to 14% of prokaryotes) at this site, while AOB and NOB populations are much smaller and do not fluctuate seasonally. The bloom commences in June with rapid growth during July, peaking in mid-August. The maximum net population growth rate we observed was ~0.5 d-1, comparable to maximum growth rates reported in pure cultures (0.78 d-1). The bloom dispersed more slowly through the fall. Surveys indicate that the AOA bloom is a general feature of the saltmarsh-dominated portions of the GCE-LTER study site, but that it does not extend into the river-dominated Altamaha Sound. Offshore transects indicate that the bloom is restricted to shallow coastal waters. The bloom has a profound effect on the composition of the dissolved inorganic nitrogen (DIN) pool in these waters. Rapid oxidation of the NH4 pool to NO2 outstrips the ability of NOB to oxidize it further to NO3 and of denitrifiers to remove it by conversion to N2. As a consequence, NOx and DIN concentrations peak in August, with interannual variability that correlates with AOA abundance. Similar patterns in DIN dynamics are observed at other salt-marsh dominated sites along the SE USA coast, suggesting that this is a general characteristic of these ecosystems. Statistical analysis of environmental data from the study site indicates that the bloom coincides with a variety of factors associated with the summer increase in net ecosystem heterotrophy reported for the study site. Lab experiments indicate a very strong dependence of growth and ammonia oxidation rates on temperature, with optimal growth at ~30 oC and no growth below 8 oC or above 35 oC.

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LONG-LINE MUSSEL PRODUCTION AS A TOOL FOR MITIGATION OF NUTRIENTS IN COASTAL WATERS

Long-line mussel farming has been proposed as a mitigation tool for removal of excess nutrients in eutrophic coastal waters and with the prospective of recycling valuable nutrients back to land through production of proteins and lipids. Mussel farming has the potential as a cost-effective measure to reduce nutrient concentrations in coastal waters and contribute to management of excess nutrients in coastal waters. Mussel farming is known to modify the environment in various ways, either positively by clearing the water through filtration and thereby improving conditions for benthic primary producers or negatively by increasing sedimentation of biodeposits and thereby increasing sediment metabolism and release of nutrients back to the water column. In this study the environmental interactions of mussel farming under mitigation principles were explored in a eutrophic fjord. The focus was on the cycling of nutrients in the water column and sediments to assess the net nutrient removal in a mitigation farm. The nutrient cycling in the farm was compared with the removal of nutrients during the production cycle to evaluate the optimal production scheme for maximizing the effectiveness of the mitigation tool. At the same time the cost-effectiveness of the nitrogen mitigation at the farm was assessed through analysis of the costs of production and effects on nitrogen uptake, and it is concluded that long-line mussel farming is a cost-effective tool of mitigation of excess load of nutrients when compared to existing land-based mitigation tools.

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A TALE OF THREE COASTS: TEMPORAL AND SPATIAL VARIATION IN BALLAST WATER MANAGEMENT TO REDUCE INVASION RISK

Shipping acts as an important driver of changing species composition and ecosystem function in seaports and coastal waters around the globe due to the massive transfer of organisms associated with ballast water and hull fouling. Although this is widely appreciated, shipping exhibits a high level of temporal and spatial variation, which has consequences for invasion dynamics that are underexplored. Here we compare commercial vessel traffic patterns, ballast water management and propagule pressure through time for three major U.S. port systems: Chesapeake Bay (East Coast), Galveston Bay-Houston (Gulf Coast) and Prince William Sound (West Coast). In the Chesapeake Bay most ballast is discharged from overseas vessels, and the annual volume of reported overseas ballast discharge has increased 10-fold since 2005 to approximately 22 million m3 in 2012 despite a similar number of annual vessel visits. Although the proportion of reported annual coastwise and overseas arrivals to Gulf Coast ports remains similar, the rate of ballast discharge has tripled in the last 8 years to 34 million m3 year-1. In contrast, Prince William Sound continues to receive the majority of its ballast water from coastwise routes, also exhibiting a 3-fold volume increase in ballast water discharge reported from 2005–2012 despite a decline in arrivals, reaching 12 million m3 year-1. The concentration of plankton currently arriving in ballast water to these different seaports varies by orders of magnitude due to complex global trade patterns and various environmental factors. This study further examines the current status and limitations of ballast water management in each region, creating strong geographic differences in vessel behavior, organism transfer and invasion potential.

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CLIMATE CHANGE AND THE RESILIENCE OF A GLOBALLY VALUED ECOSYSTEM SERVICE OF TIDAL WETLANDS – C SEQUESTRATION

C sequestration via burial of plant-derived organic matter in sediments of coastal wetlands is on the order of 70 – 220 Tg C yr-1. While the expanse of these systems is small globally, areal rates of C burial are among the highest of Earth's ecosystems. However, this globally relevant ecosystem service provided by coastal wetlands is highly vulnerable to aspects of climate change and land use change. Resilience of coastal tidal wetlands, the process of organic matter burial and preservation, and the magnitude and value of this ecosystem service are threatened and already showing signs of decline. Sea-level rise will likely increase rates of shoreline erosion, reversing a several thousand year trend in progradation. Transgression will likely slow as a result of coastal armoring to protect upland uses of higher local value. Increased rates of SLR may also compromise the ability of tidal wetlands to accrete vertically, which would result in inundation, loss of area and decreased C sequestration. Simulation results suggest a maximum rate of SLR that is conducive to wetland resilience that varies by tidal range and suspended sediment availability. As C burial is a component of net ecosystem production (NEP), which reflects the balance between production and respiration, warming is likely to decrease the C burial potential in the future. Considerable research is needed to better understand the relationships between wetland resilience and global change.

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TRADE-OFFS BETWEEN PROVISIONING AND REGULATING SERVICES IN SEAGRASS ECOSYSTEM

Understanding trade-off among ecosystem services is an important theme for ecosystem management because it strongly affects decision-making between governance and stakeholders. In particular, the potential trade-offs between provisioning services and regulating services are well-known patterns which are suggested as the major factor causing many ecosystem degradation. Seagrass ecosystem is well recognized as one of the most effective nursery habitat supporting high rates of secondary productivity. The seagrass associated animals include many fishery-important fish, crab and prawn species, therefore seagrass vegetative structure drives high provisioning services. In addition, seagrass ecosystem is also known as the most effective natural carbon sink. Therefore both provisioning services and regulating services of seagrass ecosystems are controlled by the same function of vegetative structure, so that seagrass ecosystem is considered as a rare ecosystem without trade-off among ecosystem services. In this study, however, we reported the trade-off between provisioning and regulating services even in seagrass ecosystems. We examined relationships among eelgrass vegetative structure, the provisioning service, and the regulating services in large spatial scale using a method integrating local field census with GIS/RS analyses. The results showed clear different patterns in the relationship between each ecosystem service index and spatial distribution of vegetative structure, resulting in negative relationship between provisioning service and regulating service along the gradient of vegetative shoot density. Eelgrass shoots have high morphological plasticity depending on local environmental condition, so that the vegetative structure also exhibits high spatio-temporal variability. Our results suggest that integrative approach of GIS with local field census can contribute the effective management of ecosystem services in seagrass ecosystems.

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THE IMPACT OF DENSITY STRATIFICATION ON SEDIMENT TRANSPORT IN THE RHINE REGION OF FRESHWATER INFLUENCE

This work will describe the mechanisms by which the outflow from the Rhine River affects sediment transport along the Dutch coast. I will present observations from the STRAINS (STRAtification Impacts on Nearshore Sediment) experiment, which took place February - March 2013 and was designed to investigate the role of density stratification on sediment transport. The measurements included periods of persistent stratification and a period in which there was no stratification when the freshwater was forced well offshore by northeasterly winds. Comparison of these periods shows a pronounced effect of stratification; cross-shore sediment transport is near-zero in the absence of stratification and is similar in magnitude to the alongshore transport when stratification is present. The effect of stratification is to generate cross-shore velocity due to tidal straining and the passage of the plume front, which drives sediment offshore at depth. This mechanism generates a seaward flux of sediment at our nearshore mooring. However, we observe a landward flux at a site further offshore, resulting in convergence of sediment flux midshelf. I will investigate the mechanisms leading to this asymmetry in the fluxes and the resulting convergence.

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MODEL AND OBSERVATIONS OF EASTERN LONG ISLAND SOUND

Observations and a numerical model of Long Island Sound (LIS) are used to diagnose circulation, transport and momentum balances in the eastern sound. Previous observational and modeling studies have focused on western and central LIS and Block Island Sound, but few moored measurements have been made in The Race, where the exchange between LIS and the shelf is focused through a deeper, narrow gap between small islands in the eastern sound. Velocity, pressure, and bottom stress measurements from periods of high and low river flow are used to truth model output. The unstructured grid model (FVCOM) resolves the complex coastline and islands, allowing us to extend our analysis over the entire water depth and width of the Sound.

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USE OF INTERTIDAL OYSTER AQUACULTURE, EELGRASS AND UNSTRUCTURED HABITATS BY JUVENILE SALMON IN WILLAPA BAY, WASHINGTON

Structured benthic habitats such as salt marshes, seagrass beds and oyster reefs are recognized as critical nurseries for juvenile fish and crustaceans in estuaries. Most U.S. West coast estuaries include substantial areas of unstructured habitat such as intertidal sand and mud flats, eelgrass, and areas that are utilized for shellfish aquaculture where structure exists in the form of oysters or clams being grown on or under other structures. We quantified the areas of all intertidal habitats in Willapa Bay, Washington where 20% of the intertidal area is utilized for shellfish aquaculture. We characterized use of these habitats by fish and targeted juvenile salmon using townets. Shiner perch (*Cymatogaster aggregata*) were the only fish that exhibited a significant relationship with structured eelgrass and oyster habitats while juvenile salmon were captured in similar abundance over all three bottom types. Juvenile Chinook salmon (*Oncorhyncus tshawytscha*) were the most common species captured, grew and utilized the estuary throughout the summer and abundance was associated with location in the estuary. Chinook salmon diet was also not directly correlated with benthic habitat, but instead consisted primarily of planktonic prey items like decapod larvae and other surface oriented prey like insects associated with marsh or terrestrial sources.

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ANAEROBIC AMMONIUM OXIDATION (ANAMMOX) BACTERIA AND ASSOCIATED ACTIVITY IN INTERTIDAL SEDIMENTS OF THE YANGTZE ESTUARY

Over the past several decades, concentration of reactive nitrogen in the Yangtze estuarine and coastal water has increased by more than ten folds, due to human activities in the Yangtze River Basin. As a result, the excessive load of nitrogen has caused the severe eutrophication in the estuarine ecosystem. Therefore, it is of significance to trace the fates of reactive nitrogen. Anaerobic ammonium oxidation (anammox) has been reported to play a significant role in the removal of reactive nitrogen in aquatic ecosystems. In this study, anammox bacteria and associated activity were investigated using molecular and isotope-tracing techniques. It is observed that the anammox bacteria at the study area mainly consisted of Candidatus Scalindua, Brocadia, Kuenenia. Salinity was found to be a key environmental factor controlling distribution and diversity of the anammox bacterial community at the estuarine ecosystem. Also, temperature and organic carbon had significant influences on anammox bacterial biodiversity. Q-PCR assays of anammox bacteria indicated that their abundance had a range of 2.63 ×105 - 9.48 ×106 copies g-1 dry sediment, with high spatiotemporal heterogeneity. The potential anammox activities detected in the present work varied between 0.94 - 6.61nmol N g-1 dry sediment d-1, which were related to temperature, nitrite and anammox bacterial abundance. Compared with denitrification, the anammox process is also a significant pathway for reactive nitrogen removal at the study area, which contributed approximately 6.6 - 12.9 % to total N2 production.

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INVESTIGATING FEEDBACKS BETWEEN SEDIMENT DYNAMICS AND OYSTER REEF GROWTH USING AN IDEALIZED 1-D MODEL

Sedimentation has been identified as an important factor that can limit oyster reef restoration success. Previous field studies have demonstrated that high relief reefs are more productive and resilient to disturbance than low relief reefs because increasing the reef height can reduce sedimentation and enhance oyster growth. In this study we investigated the relationship between initial reef height and reef survival using a simple 1-d model. The model, based on Jordan-Cooley et al. (2011), contains three coupled differential equations that describe changes in oyster volume, sediment volume, and shell volume per unit area of reef with time. In our study, the terms for oyster growth, sediment deposition, and erosion were modified from the Jordan-Cooley model to better represent these processes. A sensitivity analysis was then performed to investigate the ways in which parameters such as flow speed, sediment grain size, and ambient food concentration affect the model results. Our results suggest that the shape of the sediment concentration profile in the water column relative to the initial reef height is important for determining whether a reef will survive, while parameters that describe oyster growth control the productivity of the reef and the final reef height, if the reef does survive. Therefore, our study creates a tool that can be used to predict the relative success of restored oyster reefs under different environmental conditions and the impact of different physical parameters on reef restoration success.

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UNTANGLING THE EFFECTS OF ANTHROPOGENIC VERSUS NATURAL NUTRIENT SOURCES IN THE SOUTHERN CALIFORNIA BIGHT

Eutrophication of coastal waters has significantly increased in the last several decades throughout the world, with demonstrated linkages to anthropogenic nutrient inputs. Anthropogenic nutrients have been shown to provide significant sources of nitrogen that have been linked to increased primary production and harmful algal blooms worldwide and have also been associated with coastal hypoxia and acidification. Over the last decade in the Southern California Bight (SCB), the extent of algal blooms has increased, with chronic blooms documented in areas of the SCB that have major inputs of anthropogenic nutrients and significant decreases in dissolved oxygen concentrations. In upwelling-dominated ecosystems, such as the SCB, there has been a perception that anthropogenic nutrient inputs are small relative to upwelling, and thus, can have little effect on nearshore productivity. However, recent studies in the SCB have provided evidence to the contrary and have begun to untangle the relative influence of natural versus anthropogenic nutrient sources on coastal waters. A one year study in 2010 compared the source contributions of nitrogen using large regional empirical datasets combined with the Regional Ocean Modeling System (ROMS) on both regional and local scales. The anthropogenic nitrogen loads from wastewater effluent discharged to ocean outfalls were equivalent to upwelled nitrogen loads in five of six local sub-regions located proximal to the coastline. Furthermore, more recent studies of stable isotope analysis of nitrate, ammonia, and particulate organic matter showed that nitrogen from wastewater effluent comprised up to half of the total nitrogen in phytoplankton and zooplankton located proximal to an ocean outfall. These findings contradict the currently held perception that in upwelling-dominated regions, anthropogenic nutrient inputs are negligible and suggest that nearshore productivity can be enhanced from anthropogenic nutrient sources in the SCB.

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COASTAL MARSH RESILIENCY FOLLOWING DISTURBANCE ASSOCIATED WITH SEISMIC EXPLORATION FOR OIL AND GAS RESERVES

Anthropogenic disturbance can alter wetland structure and function. Extensive oil and gas extraction has occurred in wetland habitats along the northern Gulf of Mexico coast since the early 1900s, and activities associated with 3-dimensional (3D) seismic exploration for these resources can result in disturbance to plant communities. We documented the impact of a 3D seismic survey on coastal marshes in southwest Louisiana, USA. Transects were established before exploration began at two marshes affected by the survey and at nearby sites that were not affected. Vegetation, soil, and water physicochemical data were collected before the survey, within six weeks following its completion, and every three months thereafter for two years. Soil cores for seed bank emergence studies were also collected prior to the survey and at two additional times. Maximum vegetation height was significantly reduced six weeks after the survey at disturbed sites in both marshes, while height increased at control sites during this time. Total cover was also significantly reduced and dead vegetation cover increased at disturbed sites in one of the marshes at six weeks. These effects, however, were not found three months later. No survey effects on soil or physicochemical characteristics were identified. In seed bank studies, the total number of germinated seeds increased at disturbed sites in both marshes the fall following the survey, and species richness increased in one of them. Seed bank effects were not reflected in the standing vegetation. Resiliency of both marshes was indicated because any impacts resulting from 3D seismic exploration activities were short-term in that they could not be identified a few months following survey completion. The ability of the marshes to recover may have been influenced by restrictions imposed by land managers designed to minimize impacts and the oversight of survey activities by compliance monitors.

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NORTH CAROLINA COASTAL ATLAS: A TOOL FOR ESTUARINE RESEARCH AND COMMUNICATION

East Carolina University is collaborating with the North Carolina Division of Coastal Management and other partners to develop the North Carolina Coastal Atlas (www.nccoastalatlas.org), a web-based mapping and investigation platform that provides both static and interactive maps and related data for exploration and analysis. The Atlas combines physical, ecological and human use data to support education, management and decision-making. The process by which the atlas has been developed incorporates user objectives and reviews usability iteratively. A needs assessment of coastal planners, managers and other potential users revealed a desire for thematic maps in the areas of ecosystem health, biological resources, shoreline change and hazards such as flooding and storm surge. Multiple datasets are now available including sea level rise models, estuarine shoreline and associated structures, submerged aquatic vegetation, wetlands extent, and FEMA designated flood risk areas. A unique partnership with East Carolina University's Joyner Library is also making scholarly research discoverable using geotagging and spatial search. This presentation will highlight sea level rise and estuarine shoreline thematic maps, demonstrating use cases for planners in high flood risk coastal communities and the identification of protected resource areas, such as wetlands, for waterfront property owners interested in obtaining development permits. Future capabilities of the atlas include decision support tools and public engagement programs that have the potential to help make coastal and estuarine research more accessible and relevant to managers and the public.

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AN UPDATED SYNTHESIS ON MECHANISMS LEADING TO NITROGEN CONTROL OF EUTROPHICATION IN ESTUARIES

As noted by Nixon (1995), "the perception that eutrophication is widespread in the coastal marine environment and that it is a phenomenon of concern is surprisingly recent." In fact, the focus on aquatic eutrophication before 1970 was almost exclusively on lakes, and the major question was whether eutrophication in lakes was driven more by phosphorus or carbon. Increasingly since the early 1980s the perception has indeed grown that coastal marine eutrophication is a critical concern, and that this coastal eutrophication is driven primarily by nitrogen (although this conclusion remains hotly contested to this day). Encouraged in part by a workshop Nixon organized in Kenya in 1985 to compare freshwater and coastal marine ecosystems – published as a special issue of Limnology and Oceanography he edited in 1988 – we have worked to develop an understanding of the mechanisms that often lead to nitrogen limitation in estuaries and phosphorus limitation in lakes. Here, we will update our previous syntheses on this issue, focusing on two areas: the preferential input of phosphorus compared to nitrogen to estuaries from exchange with adjacent coastal marine waters (a point noted by Nixon et al. 1996, and a nutrient source lacking in lakes, which receive no nutrient inputs from downstream waters), and the role of nitrogen fixation in the nitrogen economies of aquatic ecosystems and how this influences nutrient control of eutrophication. We will emphasize a cross-systems approach and research at the mesocosm and whole-ecosystem scales.

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UNRAVELING SOURCES OF FOOD WEB SUPPORT IN THE SACRAMENTO-SAN JOAQUIN DELTA'S MARSH ECOSYSTEMS USING FATTY ACID BIOMARKERS AND MULTIPLE STABLE ISOTOPES

The current physical, biological, and chemical environment of the Sacramento-San Joaquin Delta little resembles historical conditions. A century of human alterations has dramatically transformed the Delta from a dynamic ecosystem dominated by riverine inflow, high turbidity, and vast marsh landscapes to one characterized by muted hydrodynamic variability, low productivity, and minimal marsh habitat. Adverse effects emanating from this transformation have been well documented for fishes, birds, and terrestrial wildlife reliant on natural ecosystem conditions. One major stressor for the Delta's organisms may be food limitation. Phytoplankton has decreased dramatically since the 1980's and is thought to be related to the recent pelagic organism decline. Additionally, is likely that the detrital food web is limited, as areas of internal, non-phytoplankton primary production are extremely limited within the Delta. Food limitation in the detritus-based food web, however, has received little attention in the region. Given the historical landscape of San Francisco Bay and Delta, we hypothesize that non-phytoplankton detrital material plays an important role in supporting secondary production and that estuarine fish and invertebrates are well adapted to take advantage of this resource. We therefore focus on the detritus-based food web of the Delta, using stable isotope and fatty acid biomarkers to identify origins of food web support for important prey organisms in a number of habitats, including tidal marshes, submerged aquatic vegetation, and flooded shallow water ecosystems. The results of this study may

allow restoration planners to more broadly consider the role of vegetated areas, as these areas may not only provide shelter and spawning habitat for estuarine organisms, but may bolster food web support as well.

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CONSERVATION OF HORSESHOE CRAB THROUGH EDUCATION, RESTORATION, AND LIVELIHOOD CHANGES AMONG LOCAL RESIDENTS IN TAIWAN

Living fossil, horseshoe crabs, has been on Earth for over 400 million years but as human activities thrived, horseshoe crabs are facing population decline crisis in recent decades. The Asian horseshoe crab, Tachypleus tridentatus, had once flourished on the west coast of Taiwan but now facing nearly local extinction due to habitat destruction and population exploitation. Conservation of horseshoe crab had been promoted in Taiwan, particularly in the offshore island, Kinmen Island, for many years; however in recent years we realized asides from the effort of the scientists, public involvement is equally important. Starting from 2012, a horseshoe crab conservation project to strengthen collaboration between the academic and public sectors was carried out in Taiwan main island. Xin Cen Elementary School in Budai Township, Chiayi County functions as the operational base of science popularization activities in this project. The main activities of this project are: (1) adults and students volunteer training; (2) Blue palm workshop – horseshoe crab babysitter practice; (3) promotion of national/international Horseshoe Crab Conservation Day; and (4) promotion of ecological and organic aquaculture. Through this project we wishes to achieve the following goals: (1) students and volunteers could learn accurate knowledge of horseshoe crab through rearing practices; (2) local residents could be enlightened to find out the characteristics of their hometown through horseshoe crab conservation activities; (3) local villagers could be empowered to develop an ecological village through combining horseshoe crab conservation and local livelihood. By delivering knowledge and holding a series of conservation workshop and educations on this crab to the local teachers, students, NGOs and aquaculture farmers, we anticipate both the livelihoods and conservation gain benefits.

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SEASONAL VARIATIONS OF PHYTOPLANKTON PHOSPHORUS STRESS IN THE COASTAL WATERS OF CHINA USING ALKALINE PHOSPHATASE ACTIVITY ASSAY

Due to large rivers (e.g. the Pearl and Yangtze Rivers) input, Chinese coastal waters is significant eutrophicated, which may make phytoplankton community as well as ecosystems shift. To study the phytoplankton nutrient stress and its succession, we determine the spatial and temporal (seasonal) variations of P stress of phytoplankton in the East China Sea (ECS) and the northern South China Sea (NSCS), respectively, by using alkaline phosphatase activity (APA) assay. The results showed that there were significant spatial and seasonal variations of P stress of phytoplankton in the ECS and NSCS. Averaged single-cell ELF labeling of dominant phytoplankton species/genera was higher in spring and summer (35.7±35.6%, 35.6±26.4%, respectively) than autumn and winter (15.5±14.6%, 23.1±21.9%, respectively) in the ECS. The ELF labeling of dominant species/genera (*Chaetoceros* spp., *Thalassionema* spp. and *Rhizosolenia* spp.) were higher in summer (51.8±24.5%), than spring (24.1±16.7%) and autumn(19.3±15.6%). In coastal ECS, influenced by massive Yangtze River Diluted waters, P stress of phytoplankton in summer was significantly higher than that in other seasons, which indicated the plume and extension of coastal diluted water were the major factors influencing the P stress of phytoplankton. In NSCS, temporal variations of single-cell ELF labeling of dominant phytoplankton species/genera were similar to those in the ECS. The ELF labeling of dominant species (*Chaetoceros* spp., and *Thalassionema* spp) were highest in summer (57.5±17.2%), and less in spring and autumn (43.2±17.9%, 33.9±31.6%, respectively) and lowest in winter (10.1±10.9%).

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HYDROLOGICAL MODELING IN THE BAYOU BOEUF BASIN, LOUISIANA – AN APPLICATION OF FVCOM

The Bayou Boeuf Basin in south central Louisiana includes a network of bayous and canals in forested wetlands that drain surrounding agricultural fields as well as the city of Thibodaux. Prior to the construction of flood control levees, the basin received seasonal inputs of riverine water from the Mississippi River via Bayou Lafourche. Today, flood control levees prevent these inputs, and water levels in the basin are controlled by rainfall and stormwater runoff from surrounding uplands. This stormwater contains high levels of nutrients, sediments, and other pollutants, and flows through dredged natural channels and canals. Because it bypasses wetlands most of the time and drain directly into open water bodies, water quality problems have been observed in this basin. One way to improve water quality as well as wetland viability is to restore the hydrological connectivity of the basin so that upland runoff is directed through wetlands rather than past them. A cost effective mechanism to accomplish this goal is to make a series of breaks in the existing spoil banks along major drainage channels to allow water into surrounding wetlands. The Finite Volume Coastal Ocean Model (FVCOM) was used to determine the most efficient placement of levee breaks so that maximum water exchange between the channels and surrounding wetlands can be achieved. A series of numerical experiments were performed. In addition, residence time was also calculated for each levee break scenario. Nutrient removal rate was calculated based on the formula of Dettmann (2001). The maximum reduction rate in nitrogen level was 5.7% among all scenarios. This analysis illustrates the capability of numerical model and its role in supporting science based planning and decision making.

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LOCAL EXTIRPATIONS AND REGIONAL DECLINES OF ENDEMIC UPPER BEACH INVERTEBRATES IN SOUTHERN CALIFORNIA

The upper intertidal zones of sandy beach ecosystems are increasingly threatened by impacts of human activities, erosion, and climate change. Upper beach zones typically support invertebrates with restricted distributions and dispersal. We hypothesized that the disproportionate loss or degradation of these zones has resulted in declines of upper shore macroinvertebrates across more than 400 km of southern California shoreline in the last century. From a suite of potentially vulnerable endemic upper beach fauna with direct development, low dispersal and late reproduction, we investigated historical changes in distribution and abundance of two intertidal isopod species (Tylos punctatus, Alloniscus perconvexus). Populations of these isopods have been extirpated at 57% and 64%, respectively, of historically occupied sites. Numerous local extirpations have caused regional declines and greatly reduced connectivity among populations. Two littoral cells (Santa Barbara, Zuma) currently support 74% of the remaining populations. Abundance has declined and the northern range limit of the southern species, T. punctatus, has retreated 31 km south since 1971. These isopods persist primarily on relatively remote, ungroomed, unarmored beaches with restricted vehicle access and minimal management. These predominantly narrow, bluff-backed beaches also support species-rich upper beach assemblages, suggesting these isopods are useful indicators. The high extirpation rates of isopod populations over the last century provide a compelling example of the vulnerability of upper beach invertebrates to coastal urbanization. Sea level rise will exert further pressures on upper beach zones and fauna globally. In the absence of rapid implementation of effective conservation strategies, our results suggest many upper intertidal invertebrate species are at risk.

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USING OTOLITH AND WATER CHEMISTRY TO DETERMINE LIFE HISTORY STRATEGIES OF STRIPED BASS (*MORONE SAXATILIS*) IN THE ALBEMARLE SOUND/ROANOKE RIVER STOCK

The strategic habitat areas of striped bass (Morone saxatilis) continue to be a topic of interest to researchers, fisheries managers, recreational and commercial fishermen. This research will evaluate movement and site fidelity of the key species by assessing trace elements in otoliths and water chemistry in the Albemarle Sound/Roanoke River stock of North Carolina. Key elements have been identified to determine maternal contribution of resident versus anadromous mothers. Additionally, movement on small and large spatial scales has been analyzed to determine whether mature fish were resident versus migratory. Otolith microchemical analysis has also shown that hatchery fish were naturally tagged due to elemental deposition from aquifer water used during juvenile development. As a result, researchers have been able to discriminate hatchery fish from naturally spawned fish collected in the Albemarle Sound/Roanoke River. Major advances in otolith chemistry have provided answers to key questions in identifying movement and designing effective management strategies.

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SEA LEVEL RISE AND SALTMARSHES: DEVELOPMENT, SUCCESSION AND MANAGEMENT IMPLICATIONS

Coastal saltmarshes are thought to develop by seaward progradation on accreting sediments and then by succession as plant species facilitate further accretion and their replacement by better competitors, a development threatened by increased rates of sea level rise (SLR) that exceed rates of accretion. This paradigm of saltmarsh development is challenged and the hypothesis presented that most saltmarshes develop because of SLR. Saltmarshes are

most extensive on subsiding coasts where local SLR causes their expansion inland. The succession is from the highest halophyte species, which replace terrestrial plants, to lower ones (the reverse sequence of facilitation succession). Usually this is only to mid-marsh species, which maintain an elevation in equilibrium with SLR, and not to the lower (pioneer zone) species which cannot. This explanation is consistent with saltmarsh morphology and the evidence that saltmarshes generally maintain an elevation in equilibrium with SLR. The seaward edges of most saltmarshes are cliffs, reflecting the different equilibrium elevations of vegetated mid-marsh and unvegetated intertidal flats, which seemingly preclude progradation and the initiation of facilitation succession. Increased rates of SLR will not stop most saltmarsh development by progradation, since this is unimportant, but may promote saltmarsh development by inland expansion. If this is prevented by sea walls then progradation become the only means of saltmarsh enlargement, but cannot be expected to occur naturally. The sea walls that have surrounded the estuaries of the subsiding coast of SE England for several centuries have fixed saltmarshes in their location; most saltmarsh edges have been stable for over a century, and sometimes longer. Saltmarsh creation can only be by inland realignment of sea walls or sediment recharge. Recharge may also be necessary to maintain the equilibrium elevation of saltmarshes where higher rates of SLR exceed natural accretion rates.

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SPATIAL DISTRIBUTION OF ADULT CORAL-REEF FISH POPULATIONS THAT ARE REPLENISHED BY SEAGRASS NURSERIES, AS REVEALED BY OTOLITH STABLE ISOTOPE SIGNATURES

Various fish and invertebrate species utilize inshore seagrass beds and mangroves during their juvenile stage before migrating as adults to coral reefs. Measuring the actual contribution of these nursery habitats to reef populations remains a major challenge. Fish otoliths (earbones) are very useful as natural tags due to their permanent recordings of environmental factors. Here, we determined the stable carbon and oxygen isotope signatures in the juvenile margin of otoliths of adult yellowtail snappers (Ocyurus chrysurus) from coral reefs, and compared these to the signatures in otoliths of juvenile fish collected in different seagrass nursery embayments, to trace the origin of individual reef fishes. Unique in our approach is that our experimental reef fish represent a complete population on the scale of an entire island, and that all potential nurseries were sampled. Of all adult reef fish caught, 97% were identified as having resided as juveniles in one of the seagrass nurseries, yet different nurseries contributed unequally to the total adult reef population size. Additionally, we used these data to construct a spatial simulation model that showed that adult dispersal away from reefs near nursery bays was limited. These findings indicate that the spatial distribution of nursery areas and their productivity are important drivers of population dynamics, and can lead to a source-sink structure in closed demersal fish populations. Understanding source-sink dynamics of marine animals is of major importance for the design and placement of marine reserves, especially when spatially separated habitats are used during different life stages.

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TEMPORARILY OPEN / CLOSED ESTUARIES (TOCES) AND CHANGES IN WATER QUALITY, WITH EMPHASIS ON THE ROLE OF SUBMERGED MACROPHYTES AND MACROALGAE IN NUTRIENT CYCLING

Low river inflow, weak flushing, long residence time and frequent closure make temporarily open/closed estuaries (TOCEs) vulnerable to nutrient enrichment and a build-up of organic matter. This study investigated the role submerged macrophytes and macroalgae play in storing and removing N and P from the Great Brak Estuary located on the south coast of South Africa. A budget approach was used and showed that during the closed phase, sediments were the highest contributors of TN and TP, followed by the submerged macrophytes and macroalgae. From the time of mouth closure until the mouth opened again, the dominant macroalga Cladophora glomerata stored 9396 kg TN and 2124 kg TP. The sediment constantly contributed about 30 % of the TN and 40 % TP while the submerged macrophytes and macroalgae contributed 20 to 30 % TN and 30 to 38 % TP toward the nutrient budget. River inflow and precipitation contributed less than 3 % of the TN and TP input. Nutrient budgets often do not take the vegetation within an estuary into account and especially so in TOCEs. This research serves to indicate the direction in which the small microtidal estuaries of South Africa and the world are heading. As the population increases and the associated activities which require freshwater increase, less water becomes available to estuaries and TOCEs will remain closed for longer (years). It was previously thought that the sediments of South African TOCEs did not have the necessary organic stock to fuel primary production. Two important findings arose from this research; namely that the sediment does have the necessary organic stock to fuel production, and that the submerged macrophytes and macroalgae make a significant contribution to nutrient cycling.

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SEASONAL CHANGES OF WATER COLUMN CHLOROPHYLL A, NUTRIENTS AND EPIPHYTE BIOMASS IN RESTORED AND NATIVE SEAGRASS BEDS IN PENSACOLA, FL

In response to the degradation of Florida's seagrass communities, the Florida Department of Environmental Protection's Northwest District (FDEP NWD) has focused seagrass restoration efforts using salvaged seagrasses from marine construction projects, as well as micropropagation of R. maritima. This study compared FDEP seagrass transplant locations, naturally vegetated areas, and bare sediments in an attempt to explain why some areas are more suitable than others for the recolonization of seagrass in terrigenous sediments as in the Pensacola Bay system. Seasonal changes in epiphyte biomass, overlying water nutrients and chlorophyll a concentrations were measured at seven locations were included in this study: Big Lagoon, Bruce's Beach, Escribano Point, Naval Live Oaks, Project Greenshores, and Wayside Park. Sample collection began in March 2010 and continued until September 2012, with most of the sampling occurring between early spring to late fall. Epiphyte loads on leaves was high, usually exceeding 0.5 µg chla/cm2. High nutrient concentrations can lead to enhance water column chlorophyll a and epiphyte biomass, reducing available light to seagrasses.

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EFFECT OF TEMPERATURE ON *PROCHLOROCOCCUS* GROWTH RATE AND CARBON UPTAKE

Oligotrophic oceans are numerically dominated by the marine cyanobacteria Prochlorococcus with open ocean seawater samples reaching biomass densities of 105 cells L-1. Roughly one quarter of marine primary production in the open ocean is generated by Prochlorococcus or globally about 10%. Prochlorococcus strains are divided into ecotypes defined primarily by their adaptation to light intensity and temperature. The two dominant ecotypes that thrive in high light conditions are high light I (eHLI) and high light II (eHLII) with the latter growing well in warm waters and the former in cold. It is this dominance in numbers and primary production that make Prochlorococcus a key player in open ocean ecosystems and global biochemical cycles. Here we show the effect of temperature on Prochlorococcus growth rates, carbon uptake rates and carbon allocation for 3 Prochlorococcus strains MED4 (eHLI), MIT9215 (eHLII), and MIT9312 (eHLII). Temperature was found to strongly affect growth rate and the patterns observed are consistent with open ocean distributions. Carbon uptake followed similar patterns as growth rate, but the magnitude change between measured temperatures was many times greater for carbon uptake than growth rate. However, across all temperatures the allocation of carbon to particulate organic carbon (POC) and dissolved organic carbon (DOC) as a percentage of total organic carbon (TOC) for all strains remained constant. This research reveals that a large portion of carbon taken up does not go to growth and that as climate change brings warming oceans we can expect changes in Prochlorococcus distribution, the microbial loop, and carbon cycle.

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PUBLIC PERCEPTIONS OF COASTAL ECOSYSTEM SERVICE VALUES: A GULF OF MEXICO-WIDE SURVEY

Currently the benefits provided by the environment, known as ecosystem services, and their impacts on human well-being are rarely accounted for in decision-making. By default, the value of ecosystem services provided by the environment can often be treated as zero in the planning and impact assessment processes. State-level surveys were administered to U.S. Gulf of Mexico residents to determine willingness to pay for non-market ecosystem services provided by marshes, mangroves and oyster reefs. Socio-economic characteristics were collected from survey respondents and analyzed using multivariate statistics. This type of information is useful to understand how decision-making varies based on factors such as frequency of environmental resource use and knowledge of the importance of and threats to environmental systems being valued. The results of this study will impact management of coastal natural assets via utilization of ecosystem services for decision-making.

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IMPORTANCE OF REEF-DERIVED KELP AS A TROPHIC SUBSIDY IN SEAGRASS MEADOWS

Seagrass meadows are highly productive marine ecosystems, yet seagrass leaves have a limited capacity to enter the food web directly. Food webs in seagrass meadows are often considered to be driven by the detrital pathway, which can be supported by allochthonous phytoplankton material, or through epiphytic growth on seagrass. However, kelp that has been removed from reefs can subsidize production in other ecosystems in seascapes. Pathways for such subsidies in seagrass meadows have been identified, but there is no evidence of increased biodiversity or productivity. This talk will synthesise results from a range of recent studies to provide evidence that nutrients from kelp can be incorporated into and subsidize productivity in seagrass ecosystems. Studies adopted biomarker approaches using δ13C and δ15N stable isotopes and fatty acids, or a labelled (enriched) 15N isotope to trace the flow of kelp-derived nutrients through key components of the food web in seagrass meadows of south-western Australia. Dual isotopes showed that small and large fractions of sedimentary detritus were derived from kelp and seagrass, respectively, while stable isotopes and fatty acids revealed that a combination of brown and red algae and periphtyon contribute to the diet of grazers in seagrass meadows, but kelp appears to be particularly important. Labelled 15N from kelp was incorporated into the food web, while an additional manipulative experiment showed increased abundances of key consumers where kelp was present. A synthesis of results indicates that kelp can act as an important conduit of nutrient and energy transfer to seagrass ecosystems, providing a high level of connectivity between two important coastal ecosystems in a coastal seascape.

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DIRECT AND INDIRECT EFFECTS OF NUTRIENT AND SALINITY MANIPULATION ON WETLAND HEALTH: HERBIVORY AND FLOODING STRESS AS A FUNCTION OF FERTILIZATION

Traditionally, much attention has been focused on the role of mineral sediment as a limiting factor in Mississippi River Delta coastal marsh vertical accretion. However, research has shown that marsh vertical accretion may be more directly affected by the production of organic matter by marsh plants. In lower salinities, studies observed greater utilization by marsh vegetation of available nutrients. Such marsh can subsequently engage a self-regulating organic accretion response which is based in production of belowground biomass. While the roles of salinity and nutrients as limiting factors have been clarified, additional research linking elevation to *Spartina patens* growth rates suggests that submergence and subsequent flooding stress further influence wetland plant growth rates and thus accretion across a gradient of these resources and stressors. Additionally, research shows a preference among wetland grazers for lower salinity, nitrogen-rich habitat. Therefore, plugs of *S. patens* were planted in four "marsh organs" consisting each of 36 small diameter, sediment-filled PVC pipes of incremental heights that create a range of growth elevation and thus flooding stress. The marsh organs were located in existing wetlands of varied distance from the influence of the Atchafalaya River; some organs were fertilized. Following the growing season belowground biomass was harvested, sorted, dried, weighed, and will be analyzed with localized environmental measurements to assess the effect of flooding stress and nutrient addition on root growth of *S. patens*. Additionally, nutria preference for fertilized versus unfertilized vegetation was tested in a controlled setting within species of *Panicum hemitomon, Sagittaria lancifolia*, and *S. patens*. Nutria showed a significant preference for fertilized plants. It is therefore possible that benefits derived from nutrient-rich fresh floodwater could potentially be negatively impacted by increased preferential herbivory.

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NOAA'S NATIONAL ESTUARINE RESEARCH RESERVES – ADDRESSING MANAGEMENT NEEDS THROUGH CIVIC SCIENCE ENGAGEMENT

NOAA's National Estuarine Research Reserves (NERRS) is a network of 28 estuary reserves across the U.S. dedicated to addressing coastal management needs through long-term research, education and stewardship. Reserve management priorities are identified based on existing and emerging coastal management issues for planning the continued protection and use of the reserve for research, education and public use. Several Reserves have found that an integrated approach to addressing management priorities may include engaging students and volunteers (members of the public) in research and monitoring programs which meet research needs for management. Such citizen science projects afford opportunities to participants to increase their estuarine and coastal literacy, and become better stewards, while also allowing the Reserve to meet their management needs. Successful examples of projects are presented here which have generated citizen engagement, extended scientific research and helped advance resource management of estuaries. Current citizen science projects within the NERRS include monitoring American Eels at the Hudson River Estuary to further eel passage and habitat conservation goals, Horseshoe Crab Spawning studies in Delaware which inform fisheries policy decisions, water quality monitoring in Alabama that leads to best management practices for water resources, and blue crab monitoring in Texas to understand population declines of this commercially and ecologically important species.

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EELGRASS (*ZOSTERA MARINA*) RESTORATION TECHNIQUES IN SWEDEN USING SEEDS

Seagrass meadows and the ecological and economical services that they provide are declining worldwide as a result of human perturbations. Along the Swedish west coast more than 50% of the eelgrass meadows have vanished since the 1980's. As environmental conditions are improving, interest to restore lost habitats are growing, but methods are lacking for restoration of temperate eelgrass beds in Scandinavia where the short growing season create special challenges for restoration. For example, in contrast to most areas, eelgrass seeds in Sweden do not germinate after being released, but lay dormant during the winter and germinate the following spring, which may create large natural losses of seeds during the winter period. In the present study we compared two different approaches to eelgrass restoration in Sweden using seeds: (1) broad casting dormant seeds in fall, and (2) storing seeds in the lab for 9 months and broad casting them in the spring. In the field we also assessed two different techniques to decrease losses of seeds: (1) covering seeds with a thin layer of sand, and (2) adding small stones with the seeds to induce seed trapping by current, in different environmental conditions. In the laboratory, we assessed the optimal conditions for storing seeds and cues that induce germination. Preliminary results indicate that large natural losses of seeds occur during the winter, but with large variation between different environments and a seedling success varying from <1% to 10%. The effect of adding sand and stones also varied between environments. The results from the laboratory show that eelgrass seeds can be successfully stored for 9 months and that low temperature and high salinity was important to prevent premature germination. The seedling success and summer shoot density will be compared between the fall and spring seed broadcasting approaches and weighted against costs to determine the best methods for restoration of eelgrass in Sweden.

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SKILL ASSESSMENT OF MULTIPLE MODELS IN THE CHESAPEAKE BAY

Under the charge of the Environmental Protection Agency, the Chesapeake Bay Program (CBP) has developed a set of Total Maximum Daily Load (TMDL) allotments of nutrients and sediment for the six states that make up the Chesapeake Bay Watershed in the hopes of elevating the health of the Bay, primarily in regards to dissolved oxygen concentrations. In developing the TMDLs, the CBP employed its coupled watershed-water quality numerical modeling system together with an extensive set of CBP monitoring data. As the CBP addresses questions of confidence in their model predictions, the use of multiple models has entered the discussion. Utilization of a multiple model approach when evaluating the status and recovery of the Bay system could enhance the overall confidence in model projections and better define model uncertainty. Quantitatively assessing model skill in a variety of variables is necessary to compare models to use in a multiple model system. Open source modeling systems such as the Regional Ocean Modeling System (ROMS) offer a cost effective way of adequately utilizing the knowledge base of a large group of people from multiple institutions collaborating on issues within a single system. This study compares a ROMS based model to the CBP regulatory model in terms of hydrodynamics, dissolved oxygen, and nutrients to assess the skill of the two models in regards to the seasonal and interannual variability of the Chesapeake Bay. While regional differences are apparent, overall throughout the Bay both models achieve a similar model skill score in regards to dissolved oxygen, the primary indicator of Bay health by the CBP.

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INVESTIGATION INTO THE EFFECT OF SIMULATED PREDATION ON MOLTING BEHAVIOR OF CAPTIVE JUVENILE ATLANTIC HORSESHOE CRABS, *LIMULUS POLYPHEMUS* (LINEAUS 1758)

It was first hypothesized, by Rustán et al. (2011) that some particular species of trilobites from the Upper Silurian of Argentina underwent in-faunal molting to avoid predation. More evidence from fossilized molts of the other closely related groups of trilobites followed, implicating that this behavior may be ecologically induced rather than a phylogenetic signal. Trilobites became completely extinct about 250 million years ago, and their most closely related group today are horseshoe crabs (HSCs). This study is to investigate whether the juvenile Atlantic HSC, Limulus polyphemus, would seek refuge in the substrate while molting upon exposure to predation. A series of experiments were conducted to detect chemosensory and visual responses of juvenile HSCs to stimuli that would induce burrowing behavior. Results of this study report on burrowing behavior in the presence of juvenile Menippe mercenaria (stone crab), adult Callinectes sapidus (blue crab) and other potential predators of the juvenile HSC are presented here.

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HISTORIC PROCESS AND CLOSURE DYNAMICS IN CALIFORNIA COASTAL ESTUARIES FROM THE BAY BRIDGE TO THE MEXICAN BORDER

Mouth closure processes influence salinity, tidal connection and resultant habitat type for most California estuaries. Effective management requires recognition that closure of lagoons and estuaries is not a binary phenomenon, but varies in duration, frequency and degree of closure for each system. We present methods for objective assessment and quantification of closure state using a scale that extends from subtidal to dune dammed. We apply this approach both to 19th century Coast and Geodetic Survey (T sheet) data and modern aerial photography. In these contexts we consider the relationship of closure state and lagoon condition to the tide, wave and hydrologic activity preceding the imagery. We also assess the influence of drainage and lagoon size as well as coastal setting on lagoon closure. Secondly we identify and classify estuarine geomorphic processes operative in the historic (19th century) landscape. Many processes evident in these historic maps no longer occur today. We assess historic process within segments of coast characterized by orientation and coherent geological control of Holocene estuary formation. The record of coastal form was analyzed within this template to identify reoccurring features related to geomorphic process. This is distinct from many assessments that attempt to determine "habitat type" from historic maps. Unappreciated aspects of historic coastal-process and subsequent change include: numerous multiple/alternative mouth systems which are a byproduct of mouth displacement by berm and dune closure; floodtide delta isolation of embayments; loss of hydrologically variable small drainage-large lagoon systems, and the dramatic early (19th Century) anthropogenic impacts in some sections of coast.

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CARBON TO CHLOROPHYLL RATIO IN TEMPERATE COASTAL WATERS: SEASONAL PATTERNS AND RELATIONSHIP TO NUTRIENTS

The carbon to chlorophyll ratio (C:Chl) was calculated for 6100 pelagic samples from 22 stations collected in the period 1990 to 2011 in Danish coastal waters. The C:Chl ratio varied systematically among stations, over the season and over the years, suggesting that nutrient and light availability are the main factors governing this ratio characterizing the physiology of phytoplankton. The mean C:Chl value for open water stations was 32 compared to 19 for the more nutrient rich estuarine locations. The seasonal variation could be described with a sinus curve with a winter value of 11 (similar for all stations) and amplitude of 15 (estuaries) and 44 (open water). Over the 22 years the C:Chl ratio increased between 0.5 to 1 pr. year concurrent with a decrease in total nitrogen concentrations and a decrease in local N-loadings of 50%. Thus, overall high values of C:Chl (up to 80-100) where found in the summer at stations with nutrient limitation and low values (about 11) where found in winter with low light and nutrient replete conditions. An empirical model could explain up to ca. 80% of the variation in the C:Chl-ratio from data for total nitrogen concentration and month compared to a constant C:Chl-value of 30. This is of crucial importance for modeling of coastal systems, as the models often are carbon based but are validated against observed chlorophyll concentrations obtained either from in situ sampling or from remote sensing. This analysis improves the understanding of the functioning of coastal ecosystem and is valuable for modeling and thereby management of coastal ecosystem in relation to eutrophication.

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SETTING ESTUARINE NUTRIENT CRITERIA IN FLORIDA: LESSONS LEARNED — PART 2

Establishing numeric nutrient criteria has been a daunting task with both technical and legal ramifications and pitfalls. While there have been significantly different viewpoints on what freshwater bodies should have numeric nutrient criteria and how those criteria should be established, the path taken to establish estuarine criteria has been somewhat smoother. The first commonly held position was that Florida's estuaries differ from each other, thus eliminating a reference system approach, which establishes generally applicable criteria based on minimally disturbed reference sites. Secondly, there was recognition that injection of local knowledge helps avoid many pitfalls. To that end, the State of Florida and the US Environmental Protection Agency adopted the estuary-specific nutrient criteria proposed by the three Gulf Coast National Estuary Programs. These criteria were resource-based and were found to be protective of seagrasses as well as providing for protection of all designated uses (full aquatic life support, recreation, and shellfish), as required by the Clean Water Act. The criteria for the remaining Florida estuaries have been developed to ensure adequate light to support seagrasses (if present), minimize the probability of harmful algal blooms, and achieving DO conditions conducive for the successful completion of the life cycles of critical fish and benthic populations. In many cases, evidence points to justification that maintaining current conditions, while taking into account natural variability in water quality, will achieve these biological endpoints. While often viewed as providing inadequate protection, maintaining current conditions in the face of continued growth in the watersheds is a formidable task. The challenge that remains is demonstrating that the proposed nutrient criteria for those water bodies that drain to the estuaries are protective of the upstream waters as well as being protective of the downstream waters.

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EARLY LIFE HISTORY RESPONSES OF TIDAL WETLAND PLANTS TO SEA-LEVEL RISE AND SALINIZATION IN THE PACIFIC NORTHWEST

Climate change is likely to alter the spatial distribution of abiotic gradients in estuaries, potentially increasing stress in tidal wetland plants. Using field and lab manipulations, we examined inter-specific variation in responses to elevated salinity and inundation in the Oregon wetland flora. The species we tested included plants occurring across a broad range of salinities and tidal elevations in the field. In 11 of 13 species, germination was strongly reduced at salinities of only 10-20. However, as adults many of these species were present in soils with dry season salinities up to 44, suggesting that low salinity periods may be important for seedling establishment. To assess growth responses to simulated sea-level rise, we transplanted seedlings of seven salt marsh species to a typical mid-marsh elevation (mean higher high water, MHHW) and to 25 and 50 cm below MHHW (the latter elevation being more typical of low marsh) in oligohaline, mesohaline and polyhaline marshes. After five weeks, increasing submergence and salinity both reduced productivity in all species, even in those frequently occurring in low to mid-elevation saline marshes. In several species, elevated salinity interactively exacerbated the effect of flooding on early plant growth. Additionally, greater flooding was usually associated with increasing shoot:root ratios, indicating a disproportionately negative effect on root biomass. Our data indicate that common tidal wetland species in the region vary in their sensitivity to inundation and salinity, but suggest that the early life history stages of a large percentage of the region's flora are negatively affected by increasing salinity and flooding. Given these responses, future sea-level rise may affect a broad suite of coastal wetland species in the Pacific Northwest, with likely consequences for ecosystem structure and function.

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DUAL STRESSORS, UNEXPECTED OUTCOME: COMBINED EFFECTS OF HYPOXIA AND OCEAN ACIDIFICATION ON JUVENILE *MACOMA BALTHICA*

Ocean acidification (OA) is estimated to have substantial negative effects on marine ecosystems worldwide. In the Baltic Sea, the system is unique in terms of pH-dynamics (low alkalinity in combination with increasing eutrophication) and species' adaptation to fluctuating environmental conditions. Large natural pH-fluctuations also occur associated with hypoxic conditions that severely reduce macrofaunal biodiversity, and are predicted to increase in amplitude and magnitude in the Baltic Sea over the coming decades. Combined

effects of OA and hypoxia still remain largely unexplored. We investigated the combined effect of low pH and low oxygen level on a benthic key-species, the bivalve Macoma balthica, by exposing newly-settled Macoma to a combination of pH 7.4 and 30 % oxygen saturation during 29 days. Experimental manipulation was acquired through controlled gas addition and the experiment was conducted in bottles with water changed every 2 days. Contrary to expectations, we found an increased survival in the combined treatment compared to either low pH or low oxygen level alone, or the control treatment. During the experiment, the individuals exposed to combined low pH and low oxygen level were also showing similar level of activity as individuals in the other treatments. Nevertheless, if the duration of the stress is prolonged, the combined impact is likely to cause a crash of the population in the area affected. We thus show that environmental conditions that Macoma already naturally experiences due to eutrophication and fluctuating pH may have a significant impact on juvenile Macoma. This is especially of concern in the Baltic Sea, which is already severely affected by multiple stressors and where the recolonization of disturbed habitats is largely depending on the post-planktonic recruitment.

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RESILIENCE IN COASTAL ECOSYSTEMS: IMPACT OF STRESSORS ON SEAGRASS POPULATION STABILITY

Seagrass population trajectories vary substantially across regional scales, suggesting degrees of resilience and stability in response to ecosystem stressors. Within coastal lagoon ecosystems, declines in seagrass populations are linked to 1) eutrophication, 2) reduced light availability, and 3) high water temperatures. Barnegat Bay-Little Egg Harbor, NJ (BB-LEH), Maryland Coastal Bays, MD (MCB), Chincoteague Bay, MD/VA (CTB) and South Bay, VA (VCB) collectively present gradients of these stressors and thus form an ideal backdrop against which to examine ecosystem resiliency and stability between systems. Eelgrass (*Zostera marina* L.) population trajectories and temperature, light, and nutrient trends in each lagoon were quantified across spatial and temporal scales. Average long term seagrass trajectories (decades) within these systems varied significantly across regional scales: VCB seagrass populations increased by 100% (due to large scale restoration efforts), MCB beds increased by 6%, CTB beds increased by 1%,and BB-LEH populations declined by 1%. Mean short-term trajectories (2007 to 2011) were similar for VCB, CTB and BB-LEH, but switched to a 61% decline in MCB. Change in seagrass cover was related to nutrients in BB-LEH, CTB and MCB. CTB and MCB was also limited by light and temperature. VCB cover was not limited by nutrients, light availability, or temperature. As coastal ecosystems become increasingly stressed globally, predicting potential large-scale shifts in communities relies on understanding ecosystem stability and resiliency in response to multiple stressors.

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WHAT CAN WE LEARN FROM SYNTHESIS OF LONG-TERM OBSERVATIONS IN ESTUARIES?

Scott Nixon was renowned for his ability to synthesize many kinds of data into a coherent picture of how ecosystems work and, in the process, teach us how new knowledge and understanding emerge from a holistic perspective of these complex systems. Following his lead, we analyzed multidecadal observations from many sources to understand San Francisco Bay in the context of its landscape setting between mountains and ocean and as an ecosystem transformed by diverse human activities and climate shifts. Analyses of these long-term data reveal strong responses to six drivers that are common agents of change where land and sea meet: water consumption and diversion, human modification of sediment supply, introduction of nonnative species, sewage input, environmental policy, and basin-scale climate shifts. Measured responses to these drivers in San Francisco Bay include, respectively, shifts in the timing and extent of freshwater inflow and salinity intrusion, decreasing turbidity, restructuring of plankton communities, nutrient enrichment, elimination of hypoxia and reduced metal contamination of biota, and food web changes that decrease resistance of the estuary to nutrient pollution. Detection of these changes and discovery of their causes through environmental monitoring have been essential for establishing and measuring outcomes of policies that aim to maintain high water quality and sustain services provided by estuarine-coastal ecosystems. The many time scales of variability and the multiplicity of interacting drivers place heavy demands on estuarine monitoring programs, but the San Francisco Bay case study illustrates why the imperative for monitoring and synthesis of monitoring data have never been greater.

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BENTHIC METABOLISM RESPONSE TO TWO NUTRIENT-ENRICHMENT SCENARIOS IN A COASTAL FRINGE MANGROVE

Our understanding of a system-wide response to anthropogenic nutrient input associated with land use change is limited for tropical coastal systems, which have undergone recent population increases and associated environmental change. Tropical mangrove wetlands have the potential to function as carbon sinks by taking up and storing carbon within large organic biomass pools. The objective of this study is to determine how the primary carbon storage compartments and recycling rates in mangrove wetlans are altered under nutrient enrichment reflecting current land-use changes. Nutrients (ammonium chloride and potassium phosphate) were applied bi-weekly for 15 months in aqueous form to mimic current-day anthropogenic nutrient input of a high (50:1) or moderate (16:1) N:P ratio. Benthic metabolism was measured via inorganic carbon flux under flooded vs. non-flooded conditions using in-situ core incubations or infra-red gas analysis, respectively. Macro and micro-algae abundance were estimated from areal coverage, chlorophyll a content, and C:N:P measurements of the benthic components (litter input, sediment, algae). Results showed no significant difference of percent areal cover of macroalgae between treatment levels; however, a significant difference between C:N ratios of was evident between the control and fertilized plots, with lower C:N values of algae tissue under both scenarios of nutrient enrichment. While carbon dioxide efflux was not substantially greater under nutrient enrichment compared with controls after 15 months of fertilizer addition, higher values were found in long-term impacted mangrove sites. These results add to the increasing body of knowledge of how land-use changes in tropical ecosystems influence system metabolism and carbon storage along a tropical coastline.

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USING EXISTING COASTAL MODELS TO ADDRESS OCEAN ACIDIFICATION MODELING NEEDS: AN INSIDE LOOK AT SEVERAL EAST- AND GULF-COAST REGIONS

Ecosystem forecast models have been in development for many US coastal regions for decades in an effort to understand how certain drivers, such as nutrients, freshwater and sediments, affect coastal water quality. These models have been used to inform coastal management interventions such as imposition of total maximum daily load allowances for nutrients or sediments to control hypoxia, harmful algal blooms and/or water clarity. Given the overlap of coastal acidification with hypoxia, it seems plausible that the geochemical models built to explain hypoxia and/or HABs might also be used, with additional terms, to understand how atmospheric CO2 is interacting with local biogeochemical processes to affect coastal waters. Examples of existing biogeochemical models from Galveston, the northern Gulf of Mexico, Tampa Bay, West Florida Shelf, Pamlico Sound, Chesapeake Bay, and Narragansett Bay will be presented and explored for suitability for ocean acidification modeling purposes.

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REGIME SHIFT IN A SELF-ORGANIZED COASTAL WETLAND ECOTONE

The landward coastal zones of the Everglades are characterized by sharp ecotones between mangroves and freshwater plants such as sawgrass and hardwood hammocks. Empirical studies show a gradual landward migration of these ecotones in some areas, due to sea level rise (SLR), and evidence in some areas of rapid change from freshwater plants to mangroves, possibly as regime shifts resulting from salinity overwash from storm surges. The exact causes for specific changes can be elusive. Here, we investigated the plausibility of storm surge related regime shifts of freshwater plants to mangrove forests. To understand potential regime shift processes, resilience mechanisms of coastal wetland ecotones against small disturbances should be investigated too. We develop a model of the ecotone between those vegetation types, taking account the influence of environmental gradient of salinity, caused by tidal flux, and a self-reinforcing feedback that plants alter environments to their benefit. The model simulations reveal that the self-reinforcing feedback increases the sharpness of boundaries, and maintain the stability of mangrove/ freshwater plants ecotones against minor disturbances. The model also shows that the dry season, with its low precipitation, has a strong effect on the position of the ecotone. Importantly, modeling indicates that, in order to cause a regime shift, an overwash event must raise soil and groundwater salinity for a sufficiently long period. This work is part of an integrated project that also involves hindcasting and forecasting SLR and storm surges. The significance of this research extends to coastal areas worldwide.

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NUTRIENT STATUS AND ITS EFFECTS ON THE STRUCTURE OF PHYTOPLANKTON COMMUNITIES IN THE EAST CHINA SEA IN SUMMER

The East China Sea is one of the largest marginal seas in the world. Changjiang, the biggest river of China, discharge a large amount of nutrients into the East China Sea. Higher and higher nutrient loadings lead to more and more serious eutrophication. And the structure of the phytoplankton communities would be changed by the increasing of nutrients and the changing of nutrients ratios. 3 summer cruises were conducted in the East China Sea since 2006. Nutrients and HPLC-derived pigments were analyzed to study how nutrient concentrations and ratios affect the structure of phytoplankton community. “Chemtax” software was used to obtain the community structure of phytoplankton at class level based on pigments data. Phytoplankton biomass and community composition were strongly affected by the characterization of different water mass with the concentration of nutrients (nutrient status) and the N/P, N/Si ratios. High concentrations of Fucoxanthin and Peridinin were found in the surface water in the near shore which influenced by ChangJiang Diluted Water(CDW), with strong stratification, highest chl a concentrations and high nutrients. Indicating in the near shore eutrophic area, diatom dominated, and then the concentrations decreased gradually from the inshore to the offshoure. High Prymnesiophytes characteristic pigment 19’HF and cyanobacteria characteristic pigment Zea were found in the off shore, which influenced by Kuroshio and Taiwan Warm Current, characterized as oligotrophic area with low nutrients and low biomass. High concentrations of 19’HF was located in the northern outer shelf where mainly controlled by Kuroshio, while the peak value of Zea was located in Taiwan Warm Current control regions. High concentrations of 19’BF, the diagnostic pigment of chrysophytes, were found in Zhejiang and Fujian coastal waters.The uptake of nutrients by different phytoplankton communities was also discussed using a two-end–member mixing model.

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ADH MODELING STUDIES OF SAN DIEGUITO LAGOON RESTORATION PROJECT

San Dieguito Lagoon is located in San Diego, California. The San Diego Association of Governments, the California Department of Transportation, the San Dieguito River Valley Joint Powers Authority, and the City of San Diego propose to develop a wetland restoration plan to mitigate impacts associated with highway, transit, and bridge improvements. The study area consists of approximately 127 acres on the southern floodplain of San Dieguito River. The goal is to create at least 50-acres of tidal wetlands connected by a functional tidal inlet, and an additional 14-acre brackish marsh wetland. The project must be designed and implemented in a manner that avoids impacts and possibly improves existing wetlands, flood protection, and sediment delivery to the ocean. Preliminary engineering studies have been performed. The 1-D Fluvial-12 model created and validated in a prior restoration project by Southern California Edison was used for flood routing and sediment transport modeling. The preliminary studies indicate that it is feasible to create the desired wetlands in the study area. However, it becomes apparent that a 2-D model is required for alternatives with complex hydraulics. A feasibility study is being performed that will analyze six alternatives. The state-of-the-art, 2-D Adaptive Hydraulics (AdH) model is being used for both tidal and flood hydraulics, as well as sediment transport modeling. The AdH model has been calibrated with measured tidal series, peak flood water surface elevation, and cross-section surveys before and after a riverine storm series. The AdH results are also compared with results from the 1-D Fluvilal-12 model. The calibrated AdH model is being applied for alternative analyses and comparison. The project constraints and opportunities, project alternatives development, and evaluation of their performance based on AdH modeling results will be presented. The presentation will also discuss experiences of using the AdH model.

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CLIMATE CHANGE EFFECTS ON CYANOBACTERIA BLOOMS IN THE SAN FRANCISCO DELTA

Models of climate change indicate that estuaries will likely contend with both increasing water temperature and increasing salinity (a result of sea level rise). These drivers are hypothesized to promote the occurrence of cyanobacteria blooms globally and shift estuaries towards cyanobacteria dominance. The San Francisco Estuary Delta (Delta) may already be experiencing just such a shift. Blooms of cyanobacteria in the Delta have been increasing since 1999 and affect water quality, the estuarine food web and potentially human health. With the goal of understanding how temperature and salinity influence cyanobacteria success in the Delta, a series of small bottle experiments were conducted with changing temperatures or salinities, using field collected phytoplankton including cyanobacteria-dominant assemblages. Cyanobacteria biomass and chlorophyll-a concentration increased at higher temperatures (23°C versus 18°C), compared to diatoms and chlorophytes. Cyanobacteria also endured salinities up to 5ppt where as other phytoplankton declined ~50% at the same salinity. These data linking cyanobacteria to conditions associated with predicted climate change provides insight into potential future habitat expansion and microbial community shifts toward cyanobacterial dominance in estuaries.

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COASTAL EUTROPHICATION AS A DRIVER OF SALT MARSH LOSS

Salt marshes are highly productive coastal wetlands that provide important ecosystem services such as storm protection for coastal cities, nutrient removal and carbon sequestration. Despite protective measures, however, worldwide losses of these ecosystems have accelerated in recent decades. Here we present data from a nine-year whole-ecosystem nutrient-enrichment experiment. Our study demonstrates that nutrient enrichment, a global problem for coastal ecosystems, can be a driver of salt marsh loss. We show that nutrient levels commonly associated with coastal eutrophication increased above-ground leaf biomass, decreased the dense, below-ground biomass of bank-stabilizing roots, and increased microbial decomposition of organic matter. Alterations in these key ecosystem properties reduced geomorphic stability, resulting in creek-bank collapse with significant areas of creek-bank marsh converted to unvegetated mud. This pattern of marsh loss parallels observations for anthropogenically nutrient-enriched marshes worldwide, with creek-edge and bay-edge marsh evolving into mudflats and wider creeks. Our work suggests that current nutrient loading rates to many coastal ecosystems have overwhelmed the capacity of marshes to remove nitrogen without deleterious effects. Projected increases in nitrogen flux to the coast, related to increased fertilizer use required to feed an expanding human population, may rapidly result in a coastal landscape with less marsh, which would reduce the capacity of coastal regions to provide important ecological and economic services.

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OYSTER MORTALITY AND GROWTH NEAR BALTIMORE, MD IN MORE AND LESS POLLUTED LOCATIONS

Oyster mortality and growth was studied at four sites for this project. Two of the sites were in the upper bay where there is less pollution and two sites were in the inner harbor area. The goal of this project was to examine the survival, growth, competition and predation on juvenile oysters at sites. This information will be critical for future restoration and health of the Chesapeake Bay. We found that juvenile oysters could survive in all sites in the early summer, but the Northern, less polluted sites had high mortality after numerous rain events lowered the salinity at those sites. The oysters grew faster in the more polluted sites near the inner harbor due to the high levels of food that accompanies increased nutrient abundance (eutrophication). It is very interesting that the more polluted sites did so well and offers options for natural oyster reefs to help clean the inner harbor and other polluted areas in the region. Future projects from this work will be completed to continue elucidating the possible restoration of oysters and the benefits that will have on the Chesapeake Bay.

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INVASIVE HULL-FOULING SPECIES: EFFICACY AND IMPACTS OF CHEMICAL AND MECHANICAL CONTROLS

Hull-fouling organisms create frictional drag that slows vessels and reduces fuel efficiency. Some are invasive species that are spread among coastal ecosystems by recreational boats. Copper-based antifouling paints and in-water hull cleaning are widely used to retard and remove fouling biomass on recreational boats. However, scientific reports suggest reduced efficacy of copper paints in controlling invasive, hull-fouling species. Also, physiological impacts on non-target species have led to Washington and California policies restricting use of these paints on recreational boats. While such reduced efficacy and restrictive policies suggest a greater role for mechanical fouling control on recreational boats, Australian scientists reported that in-water hull cleaning stimulated new, hull-fouling biomass. We tested efficacy of copper antifouling paint and California in-water hull cleaning practices. Experimental panels coated with copper antifouling paint were deployed in recreational marinas of San Diego Bay, California. Invasive fouling species recruited to these panels within 6 months. By 12 months both invasive and native fouling species had recruited to the panels. Separate sets of panels with copper antifouling paint and biocide-free hull coatings were deployed in marinas of San Diego Bay and Santa Barbara Harbor. Some of these panels were cleaned with best management practices (BMPs) of the California Professional Divers Association; some were not cleaned. We found that California BMPs did not stimulate new fouling biomass. However, less fouling accumulated on copper versus biocide-free coated panels and in Santa Barbara versus San Diego. Our results suggest that an integrated pest management approach that combines control tactics is needed to maintain efficacy and reduce impacts of chemical and mechanical controls for invasive, hull-fouling species on recreational boats.

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RECONSTRUCTING EARLY LIFE HISTORY TRAITS IMPORTANT TO OCEAN SURVIVAL OF JUVENILE CHINOOK SALMON UNDER DIFFERING OCEANOGRAPHIC CONDITIONS: GROWTH-RATE, BODY SIZE, NATAL ORIGIN, AND OUTMIGRATION STRATEGY

One of the most challenging aspects in understanding population declines of anadromous fish is determining how processes occurring in freshwater, estuarine, and marine habitats influence growth, survival and reproductive success. Individual variation in migratory behavior, growth rates and body size during early life history stages can have significant population level consequences. However, empirical data quantifying where within the early life history smaller individuals may have greater mortality, and under what environmental conditions, are difficult to obtain. Here we report trends in reconstructed growth rates (otolith increment widths), fish condition (K factor), fork length, triacylglycerol lipid content (TAG), the proportion of hatchery and wild individuals (otolith sulfur isotopes), and outmigration strategies (otolith strontium isotopes) for salmon collected in the San Francisco Bay and coastal ocean. We compare sub-yearlings that emigrated in 2000 and 2001 (years of good ocean productivity) with the 2005 outmigration cohort (a year of poor ocean productivity). Preliminary findings show that significant size and growth rate selective mortality occurred in the spring of 2005 when juvenile salmon first entered the coastal ocean to feed. Fish that were larger upon exit from the San Francisco Bay exhibited greater survivorship than their smaller, slower growing equivalents. The trends exhibited in 2005 were in stark contrast to those in 2000 and 2001where no size or growth rate selective mortality was detected. Although hatcheries generally release larger juveniles, our study did not find preferential selection for hatchery fish. Otolith Sr and S isotopes were used in conjunction to determine natal origin and size at outmigration from freshwater habitats. Our data suggest that early life history traits can influence the subsequent survival of juvenile salmon in the coastal ocean.

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USING MULTIPLE SPATIAL SCALES TO UNDERSTAND COMMUNITY RESPONSES TO SPATIALLY AND STRUCTURALLY SHIFTING ECOLOGICAL LANDSCAPES

To evaluate how habitat complexity facilitates biodiversity, we must consider its importance relative to other factors shaping ecological communities. Natural landscapes are rarely contiguous, so organisms' abilities to establish in their preferred habitats vary with dispersal, geographic context, habitat availability, and local interactions. As climate change rearranges foundation species, these factors' relative influences will affect inhabitant assembly in fluctuating ecosystems. Strong local effects could prevent functional equivalence of alternative habitats. Mixed local and regional influences may generate novel communities in shifting ranges. Here, I characterize marine crustacean communities in a shifting wetland ecotone along Florida's Atlantic coast. Using spatially-nested comparisons of larval supply and settlement, I estimated species composition and distributions to evaluate the influences of dispersal, regional geographic context, and local habitat complexity on community assembly. Despite differences in settlement, species supply (s>20) was comparable across sites. Settling species represented a subset of species supply. At southern sites, where mangroves dominate, more species were found in mangroves (s=12) than in marsh patches (s=8). Along the mangrove frontier, communities did not differ by habitat (s=3 in mangroves, s=3 in marshes). Northern frontier mangroves also hosted fewer species than in their historical range (s=3 north vs. s=12 south). Widely dispersed species indicate minimal dispersal limitation and regional effects, while variation in settlement within sites and by habitat type indicates strong local structuring. Reduced local differences along the shifting frontier suggest that encroaching mangroves may still be insufficient to elicit mangrove community formation. The lower diversity of inhabitants along the frontier may also indicate the formation of novel communities where foundation species shift ranges with climate change.

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FUNCTIONAL ASSESSMENT OF THE BALLONA WETLANDS ECOLOGICAL RESERVE: 4-YEAR MONITORING SUMMARY

Coastal wetlands are unique transitional areas containing diverse groups of organisms idiosyncratically adapted to living in this highly dynamic interface between fresh and salt water. In southern California, anthropogenic stressors and impacts have significantly modified many of these coastal wetland systems; in some cases, such as the Ballona Wetlands Ecological Reserve (BWER), ecosystem functions have been lost primarily due to hydrologic modifications and development. The Ballona Wetlands Monitoring Program is in its fourth year of assessments. The Program has analyzed the functionality of the variety of habitats throughout the site by evaluating varying ecological conditions in each habitat type. For example, the California Rapid Assessment Method has been applied in all salt marsh habitat types, with comparisons to regional data. Another example is the presence or absence of certain taxa within the tidal channels that can indicate water quality, identify anthropogenic stressors to the estuary, and gauge the potential to support other trophic levels. Additionally, mapping vegetation associations over time provides data on species invasions and the overall nativity of each area. Overall, the muted effects of the tide gates and altered hydrology and topography have reduced salt marsh habitat availability and significantly modified the ecological community. Some areas have retained functions such as providing nesting habitat for species of concern, e.g. the Belding's Savannah Sparrow, while others suffer from high degrees of invasion by habitat-altering plants such as Euphorbia terracina and Cortaderia selloana. The results of these analyses will inform adaptive restoration and management actions for the BWER.

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FECAL INDICATOR BACTERIA (FIB) STRATIFICATION AND LOADING IN A TIDALLY MUTED SALT MARSH

Ballona Wetlands, one of the last remaining salt marshes in Los Angeles County, receives muted tidal flows of estuarine water contaminated by runoff from Ballona Creek. Restoration planning is underway, with a goal of restoring the system to a functioning wetland ecosystem. The goals of this study included: 1) determine FIB stratification (concentration, loading) within the water column, 2) identify associations of FIB with other water quality parameters, and 3) compare wetland FIB concentrations to the adjacent estuary. Sampling was conducted four times across full tidal cycles and throughout the water

column in 2010/11 during spring tides at a wetland station. Samples were tested for FIB (E. coli, enterococci) and turbidity (NTU); at each depth, temperature (degrees C), salinity (ppt), oxygen (mg/l) and pH were measured. Loadings were calculated by integrating the stratified FIB concentrations with the water column cross sectional volumes corresponding to each depth sampled; data were assessed using ANOVA and principal component analyses. Overall results supported previous findings relating to the effects of tidal cycles on wetland bacteria, while adding several new components including stratification and loading. Although the individual patterns often differed, both MPN concentrations and loading values displayed significant variation within the water column and tidal prism. Greatest concentrations were found during ebb flows, likely due to tidal-induced suspension of sediment; however, loading often showed the opposite effect due to the reduction of the water column during ebb tides. FIB concentrations within the estuary often were significantly greater than within the wetland tide channel, thus supporting evidence from previous studies that this muted salt marsh system can act as a sink for FIB. Results will assist in the adaptive management planning of the restoration and strategies for compliance monitoring.

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DEVELOPING A DASHBOARD OF VITAL SIGNS FOR RECOVERY OF THE PUGET SOUND ECOSYSTEM

The Puget Sound Partnership is a coalition of elected officials, state and federal agencies, Tribes, local jurisdictions, nongovernmental organizations, academic institutions, and the private sector that are working together to design a healthy Puget Sound by defining ecosystem recovery goals, selecting indicators, adopting targets, and implementing an Action Agenda to achieve recovery by 2020. Six ecosystem recovery goals include a robust food web with sustaining populations of native species; restored and protected upland, freshwater, estuarine, near shore, and marine habitats; water resources to sustain people, fish, wildlife, and natural functions; water and sediment quality safe for drinking, swimming, seafood harvesting, and protective of fish and wildlife of the region; healthy human populations; and a quality of life that is sustained by a functioning Puget Sound ecosystem. Dashboard indicators were selected for important ecosystem attributes from measures of ecosystem status, ecosystem stress (drivers, pressures, and impacts), and each were assigned ecosystem recovery targets. Based on current knowledge of the natural and social science about the Sound, the indicators selected are regularly updated measures that can reveal the status of key attributes of the ecosystem's natural and human dimensions, provide snapshots of the overall health of the Sound, and be used to evaluate management strategies. The targets are policy statements reflecting the commitment and expectation of achieving the desired recovery goals. Accurate, timely, and comprehensive monitoring and assessment data are absolutely critical to advance scientific understanding and inform adaptive management. Challenges include identifying the priority and sequence of recovery actions, building capacities and allocating resources effectively, coordinating and aligning local and regional initiatives, and providing effective outreach to engage concerned citizens and the general public.

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SEASONAL MACROMOLECULAR COMPOSITIONS OF PHYTOPLANKTON IN THE GWANGYANG BAY, SOUTH SEA OF KOREA

Macromolecular compositions of phytoplankton as an indicator food quality for higher trophic levels were investigated in the Gwangyang Bay, South Sea of Korea. Samples for macromolecular compositions were obtained from the three light depths (100%, 30%, and 1%) at 3 fixed stations in the Gwangyang Bay, from October, 2011 to April, 2013. Samples were filtered on Whatman GF/F filters (47mm) and the filters were immediately frozen and preserved for colorimetric measurements. Extractions of different macromolecular classes (proteins (PRT), carbohydrates (CHO), and lipids (LIP)) were performed and the concentrations were determined by the optical density measured with a spectrophotometer. The concentrations of PRT, LIP and CHO of phytoplankton in the water column ranged from 22.83 μgL-1 to 1096.98 μgL-1 (average ± S.D. = 211.84 ± 174.03 μgL-1), from 14.21 μgL-1 to 401.36 μgL-1 (average ± S.D. = 130.60 ± 86.04 μgL-1) and from 14.24 μgL-1 to 412.33 μgL-1 (average ± S.D. = 137.13 ± 84.75 μgL-1), respectively. The food material (FM; PRT + LIP + CHO) concentrations ranged from 170.94 μgL-1 to 1265.97 μgL-1 (average ± S.D. = 479.58 ± 208.41 μgL-1). The caloric values of the FM ranged from 5.27 to 6.98 Kcal g FM-1 (average ± S.D. = 6.40 ± 0.62 Kcal g FM-1). In terms of Kcal per cubic meter, the caloric content values of the FM ranged from 1.85 to 4.07 Kcal m-3 (average ± S.D. = 2.99 ± 0.73 Kcal m-3).

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FISHING DOWN FOODWEBS: SPATIALLY FRAGMENTED FOOD-WEBS AND THE CONNECTIONS LOST

This presentation will focus on the consequences of lost subsidies across ecosystem boundaries due to significant population declines of forage fish species along the east coast of North America. Specifically, historical trends will be used to demonstrate how economic, principally through harvest practices and land-use change, and climatic events have altered distributions and abundances of a variety of species. These changes were documented by shifts in the principal harvest methods and locations used by coastal fishing communities. The data demonstrates a decline in diadromous species and a shift to more marine-based species through the 1800's, particularly as large mainstem dams were completed and punctuated by the climatic disaster resulting from the Tambora eruption. Since then, fisheries began using more and more advanced methods and have maintained smaller spatial distributions and truncated size structure of fish populations. A meta-analysis of subsidy studies will be used to postulate on the potential consequences of the connections lost focusing on the migratory species that are at historically low population sizes. What is clear is that management decisions and century-long changes in fisheries have, without intending to do so, eroded ecological connections among what are now considered distinct ecosystems. While restoration efforts may appear daunting, the improvement of populations will have far removed positive impacts across ecosystem components.

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NUTRIENT PROCESSING AT THE LAND-WATER INTERFACE IN SUBESTUARIES OF CHESAPEAKE BAY: EFFECTS OF PROXIMITY TO SHORE AND LOCAL WATERSHED LAND COVER

As part of a study of environmental stressors at the land-water interface, we measured water quality in 41 shallow subestuaries of Chesapeake Bay between April and October, 2010—2012. In 2010 and 2011, total nitrogen and total phosphorus concentrations increased as the percentage of cropland in the watershed increased. The effects of cropland were not evident in 2012, perhaps due to the low watershed discharges that year. In all years, total nitrogen increased with the percentage of developed land in the watershed but total phosphorus did not correlate with developed land. Total N and total P decreased as salinity increased, probably due to dilution of nutrient rich water from the watershed with nutrient poor ocean water. We compared our subestuary observations to observations made by the Chesapeake Bay Program (CBP) near the mouths of the subestuaries in waters of the Bay or its major tributaries. We interpolated the CBP measurements in space and time for this comparison. Total P concentration was almost always higher within the subestuaries than in adjacent waters. When TN concentration was low, it was generally higher within the subestuaries but, when TN concentration was high, it was higher in adjacent waters than within the subestuaries. Dissolved nitrate plus nitrite concentrations were almost always higher in waters adjacent to the subestuaries than within the subestuaries. Chlorophyll a reached higher levels within the subestuaries than in adjacent waters. These observations suggest that the shallow near-shore waters of the subestuaries act as sinks for nitrate, have higher P availability, and can support denser phytoplankton populations than the estuarine waters outside the subestuaries.

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SPATIAL AND TEMPORAL RESPONSES OF MICROBIAL BIOGEOCHEMISTRY TO CHRONIC AND ACUTE ENVIRONMENTAL TRIGGERS

Microbial communities are metabolically plastic, meaning they possess redundant and diverse physiological capabilities to enable and ensure rapid response to changes in environmental conditions and/or forcing functions. However, the relative response and resilience of microbial communities and the biogeochemical processes they mediate to chronic and acute environmental triggers remains poorly documented. Environmental triggers could select for certain microorganisms or specific microbial communities and thereby bring about profound changes in microbial community composition, biogeochemical processes, and ultimately, elemental cycles. Coastal regions are subject to a number

of environmental triggers, including alterations in salinity and/or hydrologic patterns, eutrophication, and land use change (e.g. clear-cutting) that drive changes in microbiology and biogeochemical cycles. Several examples from salt marsh and mangrove ecosystems, including the microbial biogeochemical response to extreme drought, clear-cutting, and salinity alterations, will illustrate the dynamic nature of microbial-biogeochemical feedbacks across a number of temporal and spatial scales.

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ASSESSING TEMPORAL AND SPATIAL VARIABILITY IN HYPOXIA OVER THE INNER LOUISIANA-TEXAS SHELF: APPLICATION OF AN UNSTRUCTURED-GRID THREE-DIMENSIONAL COUPLED HYDRODYNAMIC-WATER QUALITY MODEL

Patterns of temporal and spatial variability in hypoxia on the inner Louisiana-Texas (LaTex) shelf were examined using FVCOM LaTex, an unstructured grid, three-dimensional, hydrodynamic-water quality model. Dynamics of dissolved oxygen was modeled using a revised version of the Water Analysis Simulation Program (WASP) that was fully coupled to a Finite Volume Coastal Ocean Model (FVCOM). The coupled model was driven by surface wind forcing, tidal forcing, offshore remote forcing, heat fluxes, oxygen exchanges at the air-sea interface, solar radiation, and freshwater and nutrient fluxes from the Mississippi and Atchafalaya Rivers. The model skill was assessed using multiple sets of observational data that included time-series of dissolved oxygen concentrations from a station within the core of the Gulf hypoxic zone (C6), dissolved oxygen concentration measurements collected during the mid-summer shelfwide cruise, and vertical dissolved oxygen profiles. The model results indicate that hypoxia originates in bottom waters on the mid-continental shelf, where several isolated pockets of hypoxic water develop during early spring and later join into a larger continuous hypoxic zone. The model accurately described the seasonal cycle of hypoxia at station C6, including the episodes of intermittent hypoxia during May and June, persistent hypoxia during July and August, and dissipation of hypoxia during September. The onset of hypoxia coincided with high stability of the water column and the initial transition from normoxia to hypoxia occurred over a period of approximately three weeks. The model results point to a significant short-term variability in the extent of hypoxic bottom waters, indicating that the size of the mid-summer hypoxic zone may not be adequately captured by a single shelfwide cruise.

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SEASONAL RESPONSES OF SEDIMENT NITROGEN FIXATION AND DENITRIFICATION IN EUTROPHIC MEDITERRANEAN-CLIMATE ESTUARIES – OPPOSITE EFFECTS OF NITRATE AND SALINITY

Nitrogen (N) cycling is integral to estuarine function, yet N-fixation and denitrification, which add and remove N, are understudied in mediterranean-type climates, such as in southern California's few remaining estuaries where anthropogenic nutrient inputs are a major concern. N cycling is further complicated by extreme wet vs. dry seasonality; N loads are typically associated with low salinity pulses during wet season storms, and N and salinity can act in opposing ways to influence N-fixation and denitrification. We measured sediment N-fixation and denitrification in unvegetated mudflats of multiple southern California estuaries under ambient and N-amended water (+300uM nitrate) treatments that simulated high tide conditions across wet and dry seasons. N-fixation rates (0–40 μmol N m-2 hr-1) were similar to other eutrophic mediterranean estuaries. N-amended treatments inhibited N-fixation up to 90%. Salinity and N-fixation were moderately to strongly negatively correlated in two estuaries, though had no detectable relationship in a third estuary. In a fourth estuary, N-fixation demonstrated a strong negative relationship between porewater salinity and N-fixation during the wettest period when N-fixation was greatest despite high porewater nitrate, though this did not hold in dry periods. Denitrification rates ranged widely (0–900 μmol N m-2 hr-1) and were affected dramatically by N enrichment, which enhanced denitrification >30-fold at some sites. The relationship between salinity and denitrification was highly variable across estuaries, suggesting level of N enrichment affects response to salinity. Our results highlight the complexity of these interactions in dynamic mediterranean-climate systems and highlight need for further studies to determine the strength and direction of interactions, especially as climate change is expected to bring more extreme wet and dry seasons, and anthropogenic influences on N inputs will remain high year-round.

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CONTROLLED ALGAL GROWTH FOR WATER QUALITY IMPROVEMENT WITHIN THE CHESAPEAKE BAY WATERSHED

Water quality in the Chesapeake Bay has declined over the last century due to human development of the watershed and associated cultural eutrophication of the bay. To reverse this trend, much research is being conducted on methods for removing nutrients from waters of the bay and its tributaries. In this study research is reported on the Algal Turf Scrubber™ (the algal turf scrubber or ATS is trademarked to Hydromentia LLC of Ocala, Florida) technology within the Chesapeake Bay watershed. In the typical ATS, algae are grown attached to a screen in a shallow (10-20 cm deep), sealed basin or floway, angled at 1 to 2 percent slope, through which water is pumped. Algae absorb pollutants as they grow and these pollutants are removed from the water by frequent harvesting (once per week during the growing season) of the algae. Six field-based, annual-cycle, experimental studies of the ATS are reviewed from across the salinity gradient of the bay from the Susquehanna River in the north to the mouth of the bay in the south. Data on algal biomass productivity, nutrient content and dissolved oxygen production are reported. Based on these studies, the ATS can remove on the order of 1 metric ton of nitrogen/ha-year and 0.1 metric ton of phosphorus/ha-year, it can add 5 metric tons of dissolved oxygen/ha-year and it can produce 30 metric tons of dry algal biomass/ha-year from polluted waters of the bay. The challenges to scale up the technology to 1000s of hectares needed to clean up the bay are discussed.

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EFFECTS OF AN INFAUNAL SUSPENSION-FEEDING BIVALVE ON SANDFLAT BIODIVERSITY AND ECOSYSTEM FUNCTION

Biodiversity loss in coastal ecosystems worldwide has prompted an urgent need to understand the contribution of species to ecosystem functioning. Infaunal suspension-feeding bivalves are recognised as key species in soft sediments because they mix surface sediments, influence community composition and enhance benthic-pelagic coupling. Here we examined how the removal of the clam Austrovenus stutchburyi from a New Zealand intertidal sandflat community influences biodiversity and critical ecosystem processes: detrital processing and uptake, benthic metabolism, nutrient regeneration and benthic primary production. In a fully factorial design we manipulated in situ 1 m2 plots the presence or absence of clams (0 or 300 m-2) and macroalgal (Ulva) detritus (0 or 62 g m-2 dry weight). The Ulva detritus (~ 5 mm2 pieces) was labelled with 13C and 15N so its uptake could be quantified in macro-and meio-fauna. The faunal manipulation occurred 1 week prior to the detrital addition then at 2 and 14 days post-addition we measured solute (nutrient and dissolved oxygen) fluxes across the sediment-water interface in light and dark benthic chambers to derive measures of ecosystem function. At the same time we also sampled fauna and sediment properties to assess benthic diversity and detrital uptake. On both sampling dates benthic metabolism (dark chamber oxygen uptake) was greater in cockle and detrital addition plots. Initial stable isotope analyses indicate high interspecific variation in detrital uptake with the greatest levels detected in a tanaidacean and a nereidid polychaete. These results will be linked to changes in benthic community structure and other measures of ecosystem function to provide a mechanistic understanding of the role of a key species in intertidal sandflat communities.

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ASSESSING METHODS FOR RESTORATION OF EELGRASS (*ZOSTERA MARINA*) ON THE SWEDISH NW COAST

More than 50% of eelgrass habitats have been lost from the Swedish NW coast in the last 30 years. Restoration of eelgrass is being proposed to assist in recovery, but restoration methods for Scandinavian eelgrass are presently lacking. We assessed two techniques for eelgrass restoration (planting shoots with and without intact sediment) in the Gullmarsfjord area between 2011 and 2012 to determine suitable methods for large-scale restoration. Shoots were cross-transplanted between 4 habitats; deep and shallow areas of an exposed and a sheltered bay, to assess importance of choosing donor meadows with similar physical conditions as the site of restoration. Adverse effects on donor meadows and labor time were assessed for each method. Overall, harvesting and planting single eelgrass shoots without sediment was 5 times faster, yielded greater than 4 times higher growth rate, and resulted in smaller negative impacts on donor meadows compared to planting with intact sediment. One year after planting, shoot density had increased on average 420% and 100% for shoots planted without and with sediment, respectively. Growth was similar in exposed and sheltered areas, but more than 700% higher at 1-1.5 m compared to 2.5-3.5 m depth. The origin of transplants had surprisingly small effects on growth. Thus, physical properties of the planting habitat, rather than shoot origin appear to be important for restoration success in these areas. Results indicate that the single shoot method constitutes a relatively efficient restoration method for eelgrass on the Swedish NW coast, with minimal negative effects on donor meadows. They also illustrate the difficulties of restoring areas where light conditions are unfavorable.

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SWIMMING IN A SEA OF SINGLE-USE PLASTICS

Approximately 80% of marine debris is from land-based sources. Plastic is the most pervasive type of pollution in the marine environment causing injury and death of numerous marine animals and birds from entanglement or ingestion. Save Our Shores has conducted over 1083 beach cleanups on the central California coast since 2008 and analysis of the data reveals that the primary composition of coastal/beach marine debris is single-use plastic. To contend with this growing problem, many coastal cities and counties have begun to ban single-use plastics. Save Our Shores has been the leader in advocating for plastic bag and Styrofoam bans on the Central Coast. We will discuss how local policy changes and fees have begun to reduce plastic in the coastal environment and how behavior change through outreach and education is the focal point for reduction in single use plastic pollution.

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EXPRESSING ECOLOGICAL IMPORTANCE IN A RISK-BASED WORLD: LINKING NUMERIC NUTRIENT CRITERIA TO WATERBODY EXPECTATIONS

To protect the integrity of US waters, the Clean Water Act calls for the development of water quality standards. One key component of these is limits for pollutants, known as water quality criteria. A cornerstone of deriving water quality criteria is determining how nutrients and other chemicals affect the goals for a waterbody set by a state or tribe, known as designated uses. By establishing a quantifiable and predictable relationship between nutrients and their effects, researchers and policy makers can communicate the consequences of pollution in a risk-based, understandable way tied to the goals for a waterbody. For the criteria to protect designated uses they should be based on organisms and processes, or assessment endpoints, that are sensitive to the pollutant. Furthermore, to encourage public buy-in, consideration should also be given to endpoints based on responses that are relatable to the public. Various research efforts and assessment frameworks have used many endpoints to evaluate ecosystem health, providing a good starting point to derive water quality criteria. This talk will communicate the work done by the US Environmental Protection Agency in cooperation with state, federal, and academic partners to explore the connections between biological and ecological responses and nutrient pollution to derive numeric nutrient criteria in estuarine and coastal waters. The presentation will walk through examples of numeric nutrient criteria development using assessment endpoints and some of the key decisions that were made during endpoint selection and criteria development. Aspects of those decisions that will be examined include development of selection factors for endpoints, data considerations when selecting endpoints, and spatial and temporal representation of endpoints for criteria development. Future research needs will also be presented. Seagrasses, phytoplankton biomass, water clarity, and dissolved oxygen will be among the endpoints discussed.

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IMPROVING SEAGRASS MAPPING FOR USE AS A RESOURCE MANAGEMENT TOOL IN SOUTHWEST FLORIDA ESTUARIES

During the 1970s, severe water quality deterioration and loss of seagrass in Florida estuaries moved the state to enact legislation to protect their threatened surface waters. The Southwest Florida Water Management District, under the directive of the Surface Water Improvement and Management Act of 1987, initiated a geospatial seagrass mapping program. Since 1988, the program has surveyed five contiguous Gulf Coast estuaries biannually to document seagrass distribution and track changes in coverage as an indicator of estuarine health. Mapping data has demonstrated its value as a tool for water resource managers in Florida. The seagrass coverage data has been used by three Florida national estuary programs to establish seagrass restoration and protection targets. During recent state and federal efforts to create estuarine numeric standards for nutrient pollution, seagrass map data was analyzed to determine biological integrity of estuaries. However, limitations of mapped data and associated error must be understood prior to setting resource targets, tracking changes in habitat coverage, or analyzing biological responses to water quality conditions. We investigated multiple types of mapping error in relation to change detection and sensitivity of mapping results and will show how uncertainties in maps impact management actions. Systematic error was identified in the 2012 map when field work revealed oyster bars were present where interpretation expected seagrass. An independent oyster mapping effort within Roberts Bay explained 28% of the loss in seagrass between 2010 and 2012 due to misclassification of 2.35 ha of oysters. Classification error of a stable benthic feature like oysters allowed for tracking of error through the time series of maps. Error propagated over several maps and the effect on overall trends was investigated. The results of this study provide recommendations for dealing with mapping limitations and solutions for addressing error.

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INFLUENCE OF DIFFERENT ARTIFICIAL REEF CONSTRUCTION MATERIALS ON OYSTER COMMENSAL COMMUNITY STRUCTURE

Oyster reefs in the Gulf of Mexico provide many important ecosystem services, including the creation of habitat and refuge for numerous species of invertebrates and juvenile fish. In turn, the commensal organisms support higher trophic levels, including economically important commercial fisheries. As the demand for oyster fisheries increases worldwide and pollution from oil spills, such as the *Deepwater Horizon* spill of 2010, further accelerates the degradation of oyster reefs, the development of artificial oyster reefs has become a necessity. Preliminary studies on commensal communities have shown a difference in species composition between between oil-contaminated and non-oiled sites within Barataria Bay, Louisiana; however, little work has been done to determine if different reef construction materials influence commensal community assemblages, particularly in areas of varying levels of oil contamination and salinity. In 2013, we assessed the diversity and relative abundance of commensal organisms found among different reef materials at two sites in Barataria Bay heavily polluted from the *Deepwater Horizon* oil spill and two control sites. At each site, replicate Vexar bags containing three different, commonly used artificial reef materials (oyster cultch, limestone rubble, and OysterKrete) were deployed for one month, after which all of the organisms collected in the bags were sorted and identified. The conclusions of this study will be evaluated to determine if there is a significant difference in commensal community structure between the different reef substrate materials, as well as between areas of varying oil contamination and salinity levels. These data could provide important implications for where and how new reefs are constructed in locations that are susceptible to oil spills, such as the Northern Gulf of Mexico where oyster reefs are in close proximity to major oil production, refinery and transport operations.

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LONG-TERM STABILITY SINCE 1984 OF UPPER ESTUARINE MARSHES IN BARATARIA AND TERREBONNE BAYS, LOUISIANA, U.S.A

Dramatic losses of coastal marshes in Louisiana have been documented for decades. Ongoing and proposed restoration efforts to save the remaining marshes are the focus of considerable debate, with the pressure of adopting broad, coast-wide strategies gaining momentum after further marsh losses were sustained following Hurricanes Katrina and Rita (2005) and Gustav and Ike (2008). However, USGS maps (Corvillion et al. 2010) indicate that, while marsh losses have occurred over the entire Louisiana coast, not every area has sustained recent significant losses (since the mid-1970s). We present evidence for the long-stability in upper estuarine marshes in the Barataria and Terrebonne estuaries using a spectral mixture model of Landsat TM data (Rogers and Kearney 2004). Marshes in Terrebonne and Barataria Bays were analyzed in 20 km wide zones away from the coast, with Zone 1 subdivided into two additional 3 km wide zones close to the shoreline; Breton Sound estuary was divided into two zones plus the two 3 km near-shore zones. Marshes farthest from the Gulf showed negligible changes over the 40 year record, with slight, but temporary, declines in marsh vegetation coverage after Hurricanes Katrina and Rita and Gustav and Ike. Marshes in zones closest to the Gulf (Zones 1 and 2) declined progressively over the study period, probably due to sea level rise. A sharper drop after the hurricanes characterized the two 3-km zones closest to the shoreline, which we interpret to reflect shore erosion since the vegetation vigor remain unchanged. Near-shore zones also were characterized by small declines in vegetative cover since 2010, which may be due to intrusion of oil from the Macondo Oil Spill. The marshes in Breton Sound were severely affected by the 2005 and 2008 hurricanes, with declines in marsh coverage/vigor of almost 80%, especially in the most landward zone (Zone 2) next to the Caernarvon diversion where nutrient levels are high from freshwater inputs.

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DENITRIFICATION AND NUTRIENT ASSIMILATION ASSOCIATED WITH OYSTER AQUACULTURE AND OYSTER REEF RESTORATION

Recent and ongoing studies seek to quantify the ability of oysters to convert nitrogen contained in phytoplankton into nitrogen gas via denitrification and to assimilate nitrogen and phosphorus into the tissues and shells of oysters. Although studies of floating aquaculture have found little evidence for enhanced denitrification, studies of on-bottom aquaculture and restored oyster reefs suggest that some types of aquaculture could significantly enhance denitrification rates. Studies of a restored oyster reef in Maryland demonstrated that deep subtidal reefs (below the euphotic zone) can have very high rates of denitrification and assimilate substantial amounts of nutrients. A subsequent study of experimental reefs indicates that subtidal reefs lying within the euphotic zone may have comparably high rates of denitrification. This study and another study conducted at on-bottom aquaculture site in the intertidal demonstrate that there is a positive relationship between oyster biomass and denitrification rates but that this relationship is non-linear. Ongoing studies of experimental oyster reefs in the intertidal suggest that denitrification rates on these reefs are generally lower, have greater variability and do not increase as rapidly with increases in oyster biomass as denitrification rates on subtidal reefs. The implications of these studies for enhancing aquaculture-associated nitrogen removal will be discussed.

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PHYSICAL CONSTRAINTS AND THE COMPARATIVE ECOLOGY OF COASTAL ECOSYSTEMS ACROSS THE US GREAT LAKES, WITH A CODA

One of my favorite papers by Scott Nixon (1988) was the story he build around the observation that marine fisheries yields were higher per unit area or per unit primary production than temperate lakes. The story, and the putative agent for the freshwater/marine difference, involved a higher energy of mixing due to tides in marine environments. Interestingly, I and my recent colleagues have taken advantage of the relatively low level of physical energy and mixing between coastal waters and offshore waters in the Great Lakes—this feature allows an accumulation of nutrient loading into nearshore waters. We have developed approaches to identify landscape input signals across strong gradients of watershed condition over the 5 lakes and across ~7500 kilometers of Great Lakes shoreline and can depict associated eutrophication gradients in the water. We are synthesizing the data linking land and water at scales from very local, to lake by lake, to a general model for the entire Great Lakes basin. In addition, I worked with Scott and later took an unusual "anadromous" career path (moving from the study of estuarine/marine ecosystems to those of the US/Canada Great Lakes), so I thought it appropriate in this tribute session to include a "coda" (with which Scott ended his paper). In this, I will emphasize sharing of perspectives and tools across limnology and oceanography, their differences notwithstanding. It won't be as good as Scott's stories, but it will be interesting. Nixon, S.W. 1988. Physical energy inputs and the comparative ecology of lake and marine ecosystems. Limnol. Oceanogr. 33(4, part 2): 1005-1025.

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A HOLISTIC COASTAL ASSESSMENT AND REPORTING FRAMEWORK THAT BALANCES ECONOMIC, SOCIETAL, AND ENVIRONMENTAL PERSPECTIVES

Coastal and estuarine waters are some of the most productive and important ecosystems on earth, providing critical food, employment, transportation, and recreation resources. Each of these resource interests may have competing goals and objectives that have importance for local, regional, and global populations. Balancing these potentially competing perspectives is challenging, and has relied on piecemeal assemblages of separate assessments with the unique perspectives of each sector. Effective management of resources and ecosystems in this context requires a new approach that balances values from economic, societal, and environmental sectors, and reports on causes, status and trends, and management progress. This approach to communicating progress toward multiple objective achievement can provide a holistic assessment useful for large system management. The University of Maryland Center for Environmental Science has pioneered the use of ecosystem health report cards as synthetic tools to assess and communicate ecosystem health status. These ecosystem health report cards are evolving to include components that assess pressure, state, and response indicators, as well as indicators that are relevant to societal and economic sectors. We are developing these new assessment and reporting tools in several large and globally significant systems. The work to date suggests that a new assessment and reporting framework is possible to communicate pressure, state, and management response measurements from a multi-sectoral perspective. We propose an approach to customizing this framework, and illustrate with current report card development projects for Chesapeake Bay, the Great Barrier Reef, and the Mississippi River Basin.

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SYNTHESIS RESEARCH IN COASTAL AND ESTUARINE SCIENCE: AN OVERVIEW

There has been growing interest in the integration of existing ideas and data to produce new synthetic models and hypotheses, leading to discovery and advancement in estuarine and coastal science. This presentation will introduce the session by providing a brief review of background information that defines what we mean by synthesis research, why its importance is growing, and how we might go about teaching it to undergraduate and graduate students. We will identify and explain a range of methods used in synthesis research, including cross-system comparisons, analysis of time series data, balance of cross-boundary fluxes, and system simulation modeling. We will also describe key elements and steps often integral to the synthesis research process, and we will use examples of published synthetic research across disciplines and focal topics to help explain the unique power of this approach. These case studies will also describe the underlying thought processes to help illustrate how synthesis is done, and they will highlight how this synthesis science has advanced basic knowledge and/or addressed resource management problems.

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GENETIC CONNECTIVITY AMONG POPULATIONS OF *RHIZOPHORA MANGLE* L IN THE CARIBBEAN SEA AND FLORIDA

The red mangrove, Rhizophora mangle L., is capable of dispersal over long distances because it produces large propagules that can survive for extended periods while floating in estuarine or oceanic waters. During the Last Glacial Maximum, the latitudinal range of R. mangle was restricted to more equatorial regions; however, over time, as temperatures increased and sea level rose, the range of this species expanded poleward and populations were reestablished throughout the Caribbean and on the Florida peninsula. During this period of recolonization, propagules which recruited to Florida may have been transported via two distinct oceanic pathways. The first pathway follows the dominant regional ocean currents (Major Currents pathway) and results in distant Caribbean mainland populations (e.g. Panama, Belize) providing propagules to the Florida peninsula, while nearby Bahamian island populations remain genetically isolated. Alternatively, if gene flow occurs via the weaker Antilles Current (Antilles Island Arc pathway), then stepwise migration along the Caribbean island chain results in greater relatedness among Caribbean Island (e.g. Puerto Rico, Bahamas) and Florida populations. In this study, we use microsatellite loci to characterize the genetic structure of seven R. mangle populations in Florida and the Caribbean to explore the potential pathways that this species may have followed during this post-glacial recolonization process. This research will illustrate the relative importance of two oceanic pathways for the passive dispersal of mangroves as well as other marine species in the Caribbean. By better understanding oceanic patterns either connecting or isolating populations in the region, these findings will provide insight to managers as to which populations may be at a greater genetic disadvantage if stochastic changes occur. This information will prove to be especially pertinent in light of potential future climatic changes.

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LANDSCAPE SETTING AND CONNECTIVITY DRIVE FINE-SCALE HABITAT USE AND MOVEMENT BEHAVIORS OF FISH IN A TEMPERATE ESTUARY: A HIGH-RESOLUTION ACOUSTIC TRACKING APPROACH

There is a general appreciation for the connection between habitat integrity and healthy fish populations. More rigorous quantitative links that describe the relationship between habitat and fishery production, however, remain elusive due in part to the seasonality, individuality, and landscape-dependence of habitat use by highly mobile fishes over a range of spatio-temporal scales. In particular, quantitative data on fine-scale (spatial and temporal) habitat utilization by fishes would help stakeholders allocate limited resources towards protecting and restoring the most valuable habitats for promoting healthy stocks. We monitored acoustically tagged red drum (Sciaenops ocellatus) at fine (sub-meter) scales to track habitat preferences and movement behaviors in a natural, open estuarine system with position data provided for individually tagged fish every 5 seconds throughout an entire summer and fall (2011). Our study focused on behaviors within an intertidal embayment defined by a mosaic of sand flat, seagrass, saltmarsh, and oyster-reef habitats. The data highlight the diversity of factors influencing the behavior of red drum at these finer scales. Factors affecting fish behaviors included proximity of particular habitats to each other, tidal cycle characteristics, patch size of alternative habitats, individuality of fish, as well as time of year. The novelty in the fine scale resolution of our study demonstrates behaviors previously undetected in studies using conventional methods.

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BREATHLESS NIGHTS ON ACID: THE EFFECTS OF CO-VARYING DIEL-CYCLING HYPOXIA AND PH ON *CRASSOSTREA VIRGINICA*

Little is known about the consequences of chronic exposure to diel-cycling hypoxia and pH which commonly occur in nutrient-enriched, shallow estuarine waters. These systems are characterized by dissolved-oxygen concentrations that, under high productivity, can cycle from supersaturated near mid-day to hypoxic in early morning hours, with pH co-varying by one unit or more daily. Laboratory experiments examined the relationship between diel-cycling hypoxia and pH and Dermo (Perkinsus marinus) disease acquisition and progression, cellular immune status, and reproduction in young adult eastern oysters (Crassostrea virginica), as well as effects upon growth of spat and adult oysters. Severe diel-cycling hypoxia significantly increased disease acquisition in previously nominally-uninfected oysters, both in conjunction with cycling pH and with continuous high pH. Surprisingly, in 2012 diel-cycling pH did not affect disease levels either in conjunction with diel-cycling hypoxia or with continuous normoxia, when compared to non-cycling pH treatments. Results from oyster hemocyte assays indicated that cycling pH stimulated the oyster immune system above baseline levels observed in oysters not exposed to cycling conditions, implying that diel-cycling pH may actually improve the immune response of oysters. In contrast, diel-cycling hypoxia suppressed immune function, supporting findings of higher disease acquisition under severe cycling hypoxia. During 2012, natural pCO2 values during normoxia were higher than desired; in 2013 experiments we are examining whether or not this may have contributed to the absence of cycling pH effects upon disease transmission and spat growth. Our results suggest that diel-cycling environmental conditions are important to consider in restoration siting because of potential population level effects on organisms, including increasing epizootics, and that such effects may be exacerbated by both climate change and further eutrophication.

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INVASIVE *SPARTINA* PROJECT INTEGRATION OF LANDSCAPE-SCALE MONITORING AND TREATMENT TO ERADICATE AN INVASIVE ECOSYSTEM ENGINEER

Although unknown at the time, the 1975 experimental introduction of non-native *Spartina alterniflora* by ACOE to stabilize dredge spoils put all future San Francisco Bay tidal marsh restoration projects at risk of domination by this ecosystem engineer. By 2000, the California Coastal Conservancy and USFWS created the Invasive *Spartina* Project (ISP) to reverse the spread of hybrid cordgrass *(S. alterniflora X foliosa)* and eventually eradicate it from the Estuary through a coordinated, regional effort. ISP is a key first step in the South Bay Salt Pond Restoration, returning 15,000 acres back to estuarine functioning. Every tidal restoration site opened in the Bay over the last 35 years had been pushed off a native marsh development trajectory by hybrid *Spartina*, resulting in low biodiversity monocultures that also act as loci of dispersal to pollute intact native marshes. Over decades of backcrossing, a hybrid swarm had formed various morphologies and phenologies capable of exploiting all tidal marsh niches from channels to high marsh ecotone. The invasion also threatened the mudflats used by more than one million migratory shorebirds on the Pacific Flyway, and clogged flood control channels large and small. However, one important denizen of the marsh found welcome refuge in the thick, tall stands of hybrid cordgrass, the endangered California clapper rail *(Rallus longirostris obsoletus)*. As the aggressive invasion engulfed fragmented marshes, clapper rail populations at some sites soared beyond historical densities, often on what was previously-unvegetated mudflat that could no longer perform its ecological services. By 2012, the hybrid *Spartina* footprint had been reduced to 39 net acres from over 800 in 2006 through the use of highly-integrated monitoring and treatment systems. This coordination and oversight allows for identification of cryptic hybrids, increases sensitivity to resident clapper rail, and provides the thorough treatment needed for eradication.

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VARIATION IN EPIBIOTIC LOAD ON THE MACROALGAE *FURCELLARIA LUMBRICALIS* AND *FUCUS VESICULOSUS* IN THE BALTIC SEA

In marine coastal habitats space is often a limiting resource for plants and sessile animals. A recruitment of marine organisms onto living surfaces leads to epibioses. Epibiosis is a widespread phenomenon in marine benthic communities and epibionts play an important role in ecosystem functioning. To date there is only a few comparative studies which simultaneously looks on differences in the community composition of epibiota on two habitat-forming macroalgal basibionts and seeks a relative importance of abiotic variables that are behind the observed variability. In the NE Baltic Sea we studied seasonality in the community composition of epiphytic sessile animals and algae on two host macroalgae – *Furcellaria lumbricalis* (Rhodophyta) and *Fucus vesiculosus* (Phaeophyceae), along eutrophication and depth gradient. We found that the epibiotic load (gDW epibiont/gDW basibiont) on macroalgae differed significantly by basibiont, season and region. Namely, *F. lumbricalis* had significantly higher epibiotic load and species richness than *F. vesiculosus* and this difference was primarily attributed to higher proportion of sessile animals on *F. lumbricalis*. In autumn basibionts had higher epibiotic loads compared to spring and summer. The epibiotic load on *F. lumbricalis* was mostly explained by nutrients and that of *F. vesiculosus* by depth. The study suggests that in addition to traditional indicators epibiont load can be used for the indication of eutrophication and ecological status of Baltic Sea waters in general.

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MANAGING SEDIMENT FOR COASTAL RESTORATION IN RESPONSE TO RELATIVE SEA LEVEL RISE

Large river deltas render coasts more vulnerable to sea level rise and associated storm surge floods. The Mississippi River Delta and Louisiana's Coastal plain are severely degrading and experiencing nearly 12 square miles of annual land loss exacerbated by human intervention, including over a century of Mississippi River engineering projects. As wetlands are extremely sensitive to sea level rise, future projections indicate that about 770 square miles of land in coastal Louisiana may be lost during next 50 years (2060) under moderate-SLR-scenario NRC I whereas this loss increases to 1750 square miles if less optimistic NRC II scenario is considered. In order to mitigate this land loss, the Louisiana Coastal Master Plan (2012) prescribes various strategies of land-building by marsh creation, barrier island restoration, and sediment diversions. Creating marshes and restoring barrier islands will

require dredging of billions of cubic yards of sand and mixed sediment whereas diversions are expected to mimic natural delta building processes. Conservative estimates indicate the total volume of sediment needed is on the order of 4-5 billion cubic yards. This amount will increase exponentially if less optimistic scenario is considered. Efficient management of this enormous volume of sediment (both fluvial and offshore) is a critical component of protection and restoration in Louisiana, and is essential for the long-term sustainability of the Mississippi River Delta plain. For the first time, the State is developing a comprehensive Louisiana Sediment Management Plan (LASMP) to manage availability and allocation of sediment resources and provide a framework to establish a working strategy for sediment management to keep up with future sea level rise. This presentation will discuss how sea-level rise expectations for the Louisiana coast are accounted for in restoration project design and sediment resource allocation, as informed through the LASMP.

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SENSITIVITY OF CIRCULATION AND BIOGEOCHEMICAL RESPONSE IN PUGET SOUND TO SEA LEVEL RISE AND FUTURE CLIMATE LOADS

Assessments using future climate conditions based on the Intergovernmental Panel on Climate Change emissions scenario (A1B) have shown that hydrology of major rivers and freshwater runoff from multiple watersheds to Puget Sound, Washington, will be affected. In general, higher winter floods and lower summer flows coupled with future sea level rise are expected to impact circulation and estuarine exchange. The effects on water properties such as temperature profiles, salinity gradients, and biogeochemical interactions are of interest due to concern over loss of coastal brackish habitats and potential impairment of water quality. In this paper we present a sensitivity analysis using the Puget Sound Georgia Basin hydrodynamic and biogeochemical model based on unstructured grid Finite Volume Coastal Ocean Model (FVCOM) framework and the CE QUAL-ICM model water quality kinetics. Effects of modified hydrology, sea level rise, and nutrient loads corresponding to years 2020, 2040, and 2070 are compared with baseline conditions from 2006. We examine potential large scale changes to the seasonal net transport through the various sub-basins within Puget Sound and also provide a relative comparison of key water quality parameters such as dissolved oxygen, nutrients, and algae. Simulation results indicate that the circulation and biogeochemical cycles within the Puget Sound Georgia Basin system are dominated by the strong estuarine exchange inflow from the Pacific Ocean. This exchange flow into Puget Sound is predicted to increase in response to the future forcing conditions resulting in higher influx of nutrient rich saline water from the Pacific Ocean. Although the magnitude of the predicted response in the main basin and deeper reaches of Puget Sound is relatively small, we note that higher nutrient loads in the intertidal zones and the shallow stratified reaches could lead to conditions suitable for algae blooms and exacerbate the low DO levels in the future.

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GULF OF MEXICO SENTINEL SITE COOPERATIVE: ADVANCING SCIENCE AND FACILITATING APPLICATION TO COASTAL MANAGEMENT

The National Oceanic and Atmospheric Administration (NOAA), in partnership with the Department of Interior (DOI), Florida Sea Grant, and three National Estuarine Research Reserves (NERRs), has initiated a northern Gulf of Mexico Sentinel Site Cooperative aimed at advancing sea level rise (SLR) prediction and assessment capabilities. The Gulf Cooperative extends from the Suwannee River in Florida west to the Pearl River on the Mississippi/Louisiana border and is one of five regions to be included in the initial phase of the program. The Cooperative seeks to improve integration, translation, and transition of coastal data and research products to facilitate planning and adaptation to SLR and inundation. To achieve this vision, the Gulf Cooperative is leveraging existing activities and assets to 1) enhance and expand SLR partnerships to maximize effectiveness of data collection, modeling, and response to this information through increased coordination and collaboration; 2) improve science based capabilities for understanding SLR and its impacts; and, 3) foster science-based decisions to support SLR and coastal inundation planning and adaptation efforts. These goals and objectives serve as the focal point for the integration of a suite of collaborative research and engagement efforts, including modeling activities and anticipated products of the NOAA-funded Ecological Effects of Sea Level Rise (EESLR) project as well as the Gulf Vulnerability Assessment led by NOAA and the Gulf Landscape Conservation Cooperatives. Additional actions will focus and build on application and outreach activities of the EESLR project, the Climate Community of Practice, and Gulf of Mexico Alliance. This presentation will discuss these activities within the Gulf Cooperative as well as long-term plans for coordination and integration.

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DEAD-SHELL ASSEMBLAGES AS A NEW WINDOW INTO BIOTIC SHIFTS ON DECADAL TO CENTENNIAL SCALES

Human stressors on coastal ecosystems are increasingly well characterized, but it is difficult to recognize ecological change, evaluate natural and anthropogenic drivers, and assess mitigation and restoration efforts without data from before the Clean Water Act. Quantitative data for mollusks and other metazoans are especially scarce, despite their importance in food webs and as ecosystem engineers. Present-day dead-shell assemblages, such as sieved from seafloor grab samples, represent an under-exploited source of data on changes in animal diversity and abundance on the decadal to centennial scales that are otherwise difficult to acquire. Meta-analyses, dynamic modeling, and individual case-studies from a range of estuarine and open shelf systems reveal that death assemblages differ from censused 'living assemblages' primarily in being temporally coarse, time-averaged samples, contrary to concerns that bias from postmortem transport and incomplete preservation dominates. Although temporal pooling damps the ability of death assemblages to detect short-term (e.g. seasonal) variation, it promotes their ability to detect significant increases and decreases in the populations of key species or functional groups at the habitat scale, estimate the abundance structure of the regional metacommunity, inventory rare species, and identify now-absent species, community states, and anthropogenically shifted baselines. Here I describe one regional field test of this approach, taking advantage of the well-known history of wastewater input and other stressors on benthic infauna of the urban continental shelf of Southern California. Notwithstanding long periods of time-averaging and high-energy conditions that could have undermined the signal, bivalve death assemblages detect km-scale environmental gradients and retain a memory of decadal-scale change in community composition, validating bivalve death assemblages as proxies of biotic composition and change.

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A NUMERICAL STUDY OF RELATIONSHIPS BETWEEN FRESHWATER DISCHARGE AND HORIZONTAL ISOHALINE IN YEOUNGSAN RIVER ESTUARY, SOUTH KOREA

The Yeoungsan-river estuary located in southwestern of South Korea is blocked from the open sea by sea-dike. Estuarine circulation system has been changed and mixing of freshwater and seawater is controlled by operating the floodgate since the construction of sea-dike. Aritificial freshwater discharge is more important factor to sea-water circulation than other physical process due to sea-dike blocking. A three-dimensional hydrodynamic model(Environmental Fluid Dynamics Code, EFDC) is applied to the Yeoungsan-river estuary system to study relationship between freshwater discharge and horizontal isohaline. The model is particularly effective at reproducing the observed temporal variations in both the salinity and current structure including freshwater discharge-induced variability. The observed structure and variations of the longitudinal salinity gradient are also well reproduced. The model shows that horizontal isohaline is more correlated to the frequency of discharge than the quantity of discharge. The spreading of freshwater during summer season with high frequency discharge is presented to 26km from the sea dike, but during non-summer months, is showed to 2~10km from the sea dike.

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CAUTIONARY REMARKS IN THE AUTO-CORRELATION ANALYSIS OF SELF-SIMILAR TIME SERIES

The auto-correlation of self-similar time series may generate spurious decorrelation structures regardless of the number of independent realizations. A self-similar time series is defined as a continuous time series having similar shapes of disturbance or amplitudes of which statistics is non-Gaussian. For instance, it can be a time series of records of river flows, rain fall, and wind speed, concentration of chlorophyll, and inertial amplitudes. In this presentation, the synthetic self-similar time series, generated based on assumed covariance functions, are evaluated, and the cautionary remarks in the analysis of this kind of time series will be discussed.

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ASSESSING SPECIES-SPECIFIC ESTUARINE FISH MOVEMENT PATTERNS THROUGH WATER CONTROL STRUCTURES IN MANAGED SALT MARSHES USING PASSIVE INTEGRATED TRANSPONDER (PIT) TECHNOLOGY

Many species of nekton inhabit estuaries during one or more life history stages for critical functions such as foraging, refuge from predators, and reproduction. The use of structural marsh management practices (e.g., water control structures, WCSs) to stabilize and enhance managed marshes has altered structure and function of many marshes, particularly in the northern Gulf of Mexico. While habitat use by nekton has been studied in managed and unmanaged marshes, species-specific nekton movement patterns through WCSs have not been examined. To address concerns that WCSs may affect the ability of nekton, particularly juveniles, to access critical estuarine nursery habitats, we employed passive integrated transponder (PIT) technology at two identical slotted WCSs (approx. 10 km apart) in the Calcasieu Lake estuary of southwest Louisiana. Antenna arrays covering both sides of the WCS slots were installed in spring 2012 to monitor movement of abundant species (e.g., red drum, spot, Atlantic croaker, striped mullet, black drum, spotted seatrout) tagged with 12 or 23 mm PIT tags. To date, a total of 602 individuals of 13 species have been tagged, 373 small juveniles (120 - 220 mm) and 229 large juveniles and adults (230 -500 mm), split equally between the two WCSs. Of the total number of individuals tagged, 18% (n = 108) were later detected at the WCSs. The mean number of days at large was 20, with a large degree of variation (SE = 66 days) due to some individuals remaining at large for long periods (max = 420 days). Two juvenile Atlantic croaker (total length = 98, 112 mm) were tagged at one WCS and later detected at the other. As has been observed at WCSs in similar salt marsh habitats, relatively few individuals (n=44; 7%) were detected transiting the WCSs. Rather, most individuals were detected on multiple occasions over hours or days as they congregated on a single side of a WCS.

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GRAZING BY BIVALVES AND ZOOPLANKTON LIMITS PHYTOPLANKTON PRODUCTIVITY IN THE UPPER SAN FRANCISCO ESTUARY, REQUIRING A SPATIAL SUBSIDY TO ACHIEVE MASS BALANCE

We calculated a mass balance of phytoplankton biomass to measure the effects of planktonic and benthic grazing on phytoplankton dynamics in the strongly tidal, river-dominated northern San Francisco Estuary (SFE). The SFE is known for studies of benthic grazing, especially by the introduced clam Potamocorbula amurensis in ~1986, although grazing by microzooplankton has been neglected. In addition, continued low chlorophyll concentration since 1987 has been attributed to other long-term changes including freshwater flow and nutrient loading. We asked whether phytoplankton continued to be suppressed by grazing and what proportion of the grazing was by clams vs. zooplankton. The mass balance, part of an intensive study of the low-salinity foodweb in 2006-2008, included estimates of light-limited primary production, phytoplankton respiration, and grazing by microzooplankton, mesozooplankton, and clams. Grazing persistently exceeded net phytoplankton growth during 2006-2008, especially for larger cells. Grazing by microzooplankton often exceeded that by clams. A spatial subsidy of phytoplankton, mainly from freshwater, roughly balanced the excess of grazing over growth. Long-term monitoring data supported these findings. Thus, the role of bivalve grazing in limiting accumulation of phytoplankton biomass in a strongly tidal, river-dominated estuary can be understood only in the context of limits on growth, total grazing, and transport.

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A FORTY YEAR FERTILIZATION STUDY IN GREAT SIPPEWISSETT MARSH, CAPE COD, MASSACHUSETTS

The long term fertilization study in the Great Sippewissett Marsh on Cape Cod has been examining the changes to salt marsh vegetation and sediment processes as a result of increased nitrogen loading since 1970. For over 40 years, increased nitrogen loads have resulted in changes in vegetation growth and composition, microbial decomposition, denitrification, and nutrient (nitrogen and carbon) burial with little loss of nitrogen to tidal water. The vegetation community has continued to shift in response to fertilizer dose from short-form Spartina alterniflora to tall-form S. alterniflora and Distichlis spicata. Microbial decomposition and denitrification has increased in response to higher nutrient loads and sediment cores revealed that δ15N values in fertilized plots were higher than control plots and increased over time, becoming heavier than the source fertilizer and continuing to increase linearly. Additionally, nitrogen and carbon burial were higher in fertilized high marsh plots but did not increase over time. These studies suggest that the bulk of the nitrogen added to the experimental plots (beyond N2 fixation) must be retained in the vegetation, buried in the sediment or released as N2 via denitrification or anammox. Nitrogen interception by salt marshes has been suggested as a means of mitigating the delivery of land-derived nitrogen loads to coastal waters. Our results suggest that at medium and high land-derived nitrogen loads, nitrogen and carbon retention and processing within the salt marsh system increase with increasing load and remain high over time.

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RELATIVE SEA LEVEL CHANGE AND COASTAL INUNDATION IN ALASKA - MONITORING STRATEGIES FOR A DATA SPARSE REGION

Unlike the contiguous United States, much of Alaska's coastline is punctuated by small populations along an otherwise unmodified coast. This extensive coastline is well-recognized as lacking in baseline coastal data such as shoreline positions, topographic/bathymetric elevations and water levels. In addition, many of Alaska's populated coastal areas are under-instrumented for traditional approaches to vulnerability mapping. The northern and western coasts of Alaska, for example, have a tide gauge density of less than one permanent installation for every 1,000 km of coastline. Due to the high expense and logistical challenges associated with equipment deployment and repeat field campaigns in remote and harsh conditions, it is imperative that coastal monitoring strategies for Alaskan communities leverage interagency collaboration and opportunistic approaches to data collection. We present an overview of baseline data collection strategies employed by the Alaska Division of Geological & Geophysical Surveys to meet the specialized needs of a geologically and socioeconomically diverse coastline in a decentralized coastal management system. Ongoing work includes (1) the collection of nearshore bathymetric measurements and onshore coastal elevations, (2) improved access to tidal and geodetic datum conversion tools, (3) rapid documentation of coastal inundation events in remote communities, (4) repeat measures of beach morphology, and (5) refinement of relative sea level change rates in western Alaska. Our presentation will provide the audience with a different perspective on collecting, organizing and distributing geospatial data in the coastal zone as we describe some of the challenges associated with quantifying relative sea level trends and coastal inundation in rural Alaska.

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HERBIVORY INDUCES AN ANNUAL LIFE HISTORY AND SELECTS FOR SEMELPARITY IN *ZOSTERA MARINA*

Recognizing the abiotic and biotic parameters that favor one reproductive strategy over another can reveal much about population dynamics and aid in understanding diverging traits in different environments. We explored abiotic and biotic causes for a population of *Zostera marina* (eelgrass) to diverge reproductively into subtidal perennial and intertidal annual zones. A hypothesis that abiotic conditions associated with differing tidal exposure environments favors an intertidal annual life history was not supported. Plants with greater exposure in a tidal simulator experiment exhibited no annual life history pattern or differentiated growth pattern relative to a subtidal treatment, and field measures of abiotic conditions differed little by depth. A second hypothesis that reoccurring seasonal herbivory by *Branta canadensis* (Canada geese) is a determinant of the intertidal annual life history pattern was supported. Field plots, half of which were caged to exclude Canada Geese, at two elevations (0.0m and -1.0m MLLW), showed that excluding geese allowed plant persistence and clonal growth at both elevations, while plants in uncaged plots disappeared. Notably, temporal morphological study of eelgrass genets in the general population found co-occurring perennial and annual morphotypes. Cryptic "true annuals" flower, set seed and die prior to the influx of Canada geese, thus contributing more progeny to future generations. Perennial plants are allocating energy to growth and storage, resources that go unutilized following geese grazing mortality events. This work identifies a biotic selective force for semelparity (a programmed annual life history) in an eelgrass population. The influential roles of herbivores in seagrass systems is increasingly being recognized, and consumers have been hypothesized as a selective force for semelparity; however, this is, to our knowledge, the first empirical example of herbivore-mediated selection toward semelparity in any plant species.

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ORGANIC MATTER DECOMPOSITION SENSITIVITY TO SOIL WARMING AND ITS ROLE IN TIDAL MARSH CARBON CYCLING

About half of marine carbon burial takes place in rapidly evolving, vegetated coastal ecosystems such as tidal marshes where fascinating interactions between sediment transport and plant growth determine whether ecosystems can survive sea level rise. It remains unknown how organic matter contributions will change in response to elevated CO2 and warmer temperatures, and whether they will enhance or diminish marsh resilience. Here, we estimate the sensitivity of organic matter decay to seasonal and latitudinal variations in soil temperature in brackish marshes dominated by C3 vegetation. We find a moderate (3-6% per degree) increase in decay rate at warmer temperatures, which is less than the sensitivity of decay previously measured in C4 dominated salt marshes (20% per degree). We will use this new data to revise an ecogeomorphic model of marsh evolution, and simulate the long-term sensitivity of coastal marshes to climate warming and accelerated rates of sea level rise. Exploratory simulations suggested that model behavior is not sensitive to subtle changes in decomposition rate, and that organic matter accumulation was instead dominated by the rate of sea level rise. Based on previous experiments, we continue to hypothesize that carbon burial rate will increase for the first half of the 21st century. However, loss of carbon through decay increases with the total size of the carbon pool. Thus, the direction of feedback between coastal carbon sequestration and climate change could switch from negative (i.e. stabilizing) to positive, an effect that would be amplified if coastal wetlands are lost to sea level rise or anthropogenic modification.

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APPROACHES TO SCALE UP ECOSYSTEM RESOURCE RESTORATION AND SCALE DOWN TOTAL CONSUMPTION BY HUMANS, AS WITH FRESH WATER SUPPLIES AROUND SAN FRANCISCO ESTUARY

Complaints abound that science inadequately communicates policy. From ecologists, environmental evidence, problems, and our solutions have been clear, but most audiences hear mainly what they wish. Long-term vs. (entrenched) short-term economics are needed to conserve and restore natural resources, now being overexploited, especially in crowded estuaries and coasts. We around Bays have unusually high levels of education, income, and property values, which might enable proper management of available resources, human population, and consumption. California water is like many natural resources: now overexploited, and increasingly valuable, more than most humans can really afford, including external costs. We attempt to trade energy for water via desalination or "purification" but other resources continue to be overexploited, with disastrous side-effects. Here, we illustrate ecological concepts and resource values as supply vs. demand, equal at human Carrying Capacity, as a maximum sustainable number of humans, if we all conserve. We use literature to calculate that (maximum) human Carrying Capacity in three different ways, which agree: we greatly exceeded our human Carrying Capacity. K is decreasing. Total consumption will crash, voluntarily or not. Probably, civilization already would have crashed if not for Drs. Ma Yinchu of China and Ehrlich of the US, who influenced recent generations to curb human population growth and consumption. Our recent publications clarify voluntary action, via suitable education. Humans must transition from short-term (growth) ecological r selection to long-term ecological (sustainable) K selection. For natural resources and processes, replacement costs go up, as does value, as supplies dwindle. Humans who profited most from over-exploitation can pay most replacement costs, since those resources were so valuable. Sooner rather than later, growth must halt, and REVERSE more and more, along with wide-scale ecosystem repair.

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THE BALTIC SEA PHYTOPLANKTON DATASET

Baltic Sea (NW Europe) belongs to the top list of the worlds' most polluted and stressed ecosystems, because of the economic activities on its drainage area as well as of its natural physical properties. A permanent halocline prevailing in deeper parts of the Baltic Sea and presence of anoxic bottom areas belong to natural state of this sea, but concurrently complicate the eutrophication abatement strategies undertaken so far. Being such a tricky system to manage, there has been a high interest in the health and changes of the Baltic Sea. To observe the state and trends of the health of the Baltic Sea ecosystem, phytoplankton species composition and abundance has been surveyed already for the last 50 years. Here I introduce the first harmonized dataset compiling the data from individual institutions around the Baltic Sea that were conducting the phytoplankton monitoring under the same methodology. Dataset consists of nearly 15 000 quantitative phytoplankton samples and 50000 records, and contains the data on the majority of samples collected during 1966-2008. First analyses of this data revealed the long-term changes in spring bloom species composition, possibly linked to the warming of winters in the area, and continuous drift of overall species composition over the observation period. Although spatial and temporal heterogeneity of the sampling frequency sets some technical limitations to the analyses, the compilation of distributed data tables into one coherent dataset broadened the horizon for the types of questions that can be asked and answered.

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AN OVERVIEW OF REGIONAL ADAPTATION EFFORTS IN SOUTHERN CALIFORNIA

The Los Angeles Regional Collaborative for Climate Action and Sustainability (LARC) was formed to create a cross-jurisdictional collaboration promoting best practices in climate change mitigation and adaption. LARC is a network designed to encourage greater coordination and cooperation at the local and regional levels by bringing together leadership from government, the business community, academia, labor, and environmental and community groups. Coordinated efforts across the region among these land use, transportation, infrastructure, energy, and resource management partners is helping us to develop system-wide strategies to address climate change. In coastal Los Angeles County, numerous separate jurisdictions comprise a system of incorporated cities, unincorporated county-managed facilities and resources, and state-managed parks and beaches. Although the municipal authorities themselves are independent entities, actions taken by any one will have effects upon the others. Addressing climate change issues in a regional context builds opportunities for cooperative and mutually beneficial planning while taking advantage of economies of scale in training, information acquisition and scientific guidance. I will explore why regional collaboration is critical for the success of climate change mitigation and adaptation planning efforts across Los Angeles County, using the region's coordinated effort around coastal impact as an example. Draft List of Possible Presenters Krista Kline, Managing Director, Los Angeles Regional Collaborative for Climate Action and Sustainability

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GETTING THE QUESTIONS RIGHT: THE ROLE OF BOUNDARY ORGANIZATIONS IN ADVANCING UNDERSTANDING OF OCEAN ACIDIFICATION AND HYPOXIA

Ocean acidification and hypoxia are as-yet incompletely understood processes that may significantly affect the future of west coast ocean ecosystems and biological resources. Therefore, the California Ocean Protection Council (OPC), a cabinet level state body that encompasses multiple agencies, formally charged the Ocean Science Trust (OST) with convening an Ocean Acidification and Hypoxia Science Panel (the OAH Panel). The mission of the OAH Panel is to advance decision-makers' understanding of drivers and impacts of ocean acidification and hypoxia by synthesizing and translating knowledge from this scientifically diverse and rapidly evolving field of research. In this talk, I will discuss OST's approach to understanding user needs on behalf of the OAH Panel. Beyond just identifying primary information needs, I will describe the development and application of a formal interview process that has also allowed us to identify optimal panel outcomes and align those outcomes with key decision points in management processes happening at multiple levels of government. These ideas around the role of interview processes as important tools in understanding user needs are rooted in OST's Agency Science Needs Assessment (ASNA). A goal of ASNA is to establish mechanisms that strengthen the relationship between scientists and decision-makers, with each constructively learning from the other. I will also link our work on behalf of the OAH Panel with the broader ASNA framework that we are building. Finally, I will discuss lessons learned to engage our colleagues about ways this work could be improved.

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CHANGES IN NUTRIENT EXPORT AND IMPORT TO YAQUINA BAY: USING HIGH RESOLUTION IN-SITU SENSORS TO EVALUATE DECADAL CHANGES IN NUTRIENT DYNAMICS AND THE EFFECT ON PRIMARY PRODUCTION IN A REPRESENTATIVE ESTUARY

In 2009, Brown and Ozretich published a high resolution sampling from 2002-2003 that established Yaquina Bay, Oregon, as a representative estuary of the Pacific Northwest. This work provided a snapshot of background conditions, seasonality, amount of oceanic nutrient inputs, and typical N:P ratio dynamics. Most studies of nutrient dynamics suffer from a limited number of samples. Because Yaquina Bay is tidally forced (~70% flushed with each cycle) a near hourly measurement interval is needed capture nutrient changes relevant to the system's temporal scales. Hourly measurement also facilitates capture of episodic rain events in the winter which can cause rapid nitrate loading. Since 2009 in Yaquina Bay we have been acquiring near continuous hourly in-situ sensor with in-situ phosphate analysis in

tandem with nitrate, chlorophyll fluorescence, and other supporting parameters (temperature, salinity, turbidity, scattering, dissolved oxygen). To our knowledge, this data set represents the longest hourly record of phosphate and nitrate measurements. Using our high-resolution data set, we are exploring if, a decade later, the gross inputs of nutrients to Yaquina bay have changed. This study evaluates if this representative system has had changes in background concentrations, dry season upwelling gross input, maximum concentrations observed, and periodicity of events. It is expected that climate change will produce changes in both intensity and periodicity of upwelling events and could also affect background nutrient levels in productive estuaries. Changes in nutrient regime will affect the amount of production, and the fraction that is imported from the coastal ocean or produced in-situ in the bay. The wet season has been little studied, due to low productivity and short bay residence times. However, expected precipitation changes associated with climate change are likely to affect the load of nitrate to the ocean from the Pacific Northwest.

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DEVELOPMENT OF A SHORE PROTECTION INDEX TO GUIDE THE SELECTION OF ECOLOGICALLY ADVANTAGEOUS SHORE-STABILIZING METHODS IN CHESAPEAKE BAY

Estuaries and coastal embayments in the Mid-Atlantic region have been significantly impacted by coastal erosion, loss of submerged aquatic vegetation (SAV), loss of marsh, and increasing shoreline hardening. An estimated 69% of Maryland's shoreline is now eroding, while 12% is already hardened,. Shoreline erosion rates are likely to increase, as well as community needs for shoreline protection, as sea-level rises due to climate change. However, the ecological effects of different shoreline stabilization structures are complex, making appropriate management decisions difficult. A variety of stabilization techniques are used in the Maryland portion of Chesapeake Bay, and while the qualitative effects of the different techniques are generally known, little quantitative, long-term information is available. In order to compare the effectiveness of different types of coastal structures in stopping shoreline erosion in an ecologically sound manner, we are developing an integrative index of shoreline protection. The index will assign between 1 and 5 points to categories such as sediment characteristics, intertidal and subtidal vegetation, post construction erosion and shoreline profiles adjacent to the structures. The points will then be added and sites with the highest numbers will indicate the most effective and beneficial structures. By adjusting parameters and numbers of points assigned we hope the index will be easily adjusted for other geographical areas making it useful for contractors and coastal managers.

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MENTORING YOUNG SCIENTISTS THROUGH VARIOUS INQUIRY EXPERIENCES: STUDENT ACHIEVEMENT RESULTS FROM A LARGE UNDERGRADUATE MARINE SCIENCES PROGRAM OFFERED AT COASTAL CAROLINA UNIVERSITY, SOUTH CAROLINA

Coastal Carolina University currently offers one of the largest undergraduate Marine Sciences programs in the country with total enrollments being between 700 - 800 students over the last several years. The curricular design of the program has a hierarchical introductory and mid-level required core but allows students upper level flexibility of 20 hrs (5 lecture courses & laboratories) that can include a wide range of subdiscipline specializations and inquiry based course designs. We have been investigating the within degree program and post-graduation impacts of course selection using; institutional student performance records, as well as cognition and perceptional surveys. Our institutional records suggest that students who select courses with laboratory sections which feature guided or open inquiry projects experience better retention and academic performance versus students that chose laboratories featuring more traditional "cookbook" exercises. Within program student surveys of our Marine Biology course laboratories, have indicated that students feel that open inquiry exercises are more rigorous than non-inquiry based exercises, BUT that they also feel strongly that the open inquiry experiences are of critical importance to their career goals. Survey results from post graduates regarding their career progression, perceived success and satisfaction as a function of upper level course choice will be presented. Finally, society based surveys to assess the prevalence of inquiry-based laboratory approaches will also be presented. Preliminary results from one society indicate >85%, use an inquiry approach in at least one lab. Structured (61%) were more common than open (29%) or guided inquiry labs (10%). Universally respondents indicated inquiry labs require greater time and effort compared to traditional approaches, but produce significant educational benefits.

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ECOGEOMORPHOLOGY OF DEVELOPING DELTAS: IMPLICATIONS FOR RESTORATION

Despite broad scale understanding of the general processes driving the evolution of deltaic systems, relatively little is known about the function processes leading to sediment deposition and accretion in the wetlands that make up deltas. This talk examine sedimentary processes in a suite of developing crevasse splays and moth bars the lower Mississippi River/ Atchafalaya River System. These systems range from ~10 meters to ~10 km in long, and with feeding discharges that vary by several orders of magnitude. The morphodynamics of these systems vary, with some systems yielding symmetrical deltas with coarsening upward sediments and other systems producing highly asymmetrical systems with fining upward sediments. Sedimentation rates in these systems vary across seasonal cycles, though they are often high enough to exceed local relative sea level rise, which in the Mississippi River Delta can range from 1-5 cm/yr. These results provide critical insights into plans to restore the Mississippi River Delta through the use of river diversions. More specifically, such plans will be most effective if: 1) sediment demands on the bayside of the delta are matched with sediment supply on the riverside 2) efforts are made to optimize sediment transport and trapping zone, and 3) the timing of vegetation growth matches the interannual variability in sediment delivery and 4) other problems, including eutrophication, are minimized.

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LINKING ORGANISMAL TOLERANCES & TRANSCRIPTOMIC RESPONSES TO CLIMATE CHANGE STRESSORS IN AN ENDANGERED FISH ENDEMIC TO THE SAN FRANCISCO BAY-DELTA

The delta smelt *(Hypomesus transpacificus)* is an endemic fish in the San Francisco Bay–Delta and is an important ecological indicator species. Delta smelt have been rapidly declining in the past 30 years due to a variety of physiological and ecological stressors, and climate change is expected to further impact this species by altering regional temperatures and salinities. The delta smelt is also an annual migratory species that encounters differential thermal and salinity regimes across ontogenetic stages. Some studies have investigated whole organism tolerance to these stressors in adults, but little is known about how tolerance thresholds or their mechanistic drivers vary through development. We sought to understand climate change impacts on delta smelt by conducting a series of thermal and salinity exposures on both chronic and acute timescales. We assessed tolerance by measuring loss of equilibrium and proportional survival, and quantified changes in gene expression to evaluate sublethal stress responses. Larval stages (30 and 60 days post-hatch, dph) of delta smelt exhibited higher thermal tolerance relative to juvenile (150 dph) and adult stages (200 dph), but were more sensitive to salinity than these older stages. Linking tolerance data to transcriptomic profiles, we detected induction of osmotic, oxidative and other sublethal stress responses with increasing temperatures and salinities. Many transcriptomic responses occurred at lower levels and on shorter timescales relative to whole organism tolerance thresholds, and both tolerance and transcriptomic responses differed among life-stages. Therefore, delta smelts' ability to deal with environmental change may depend on the timing and magnitude of abiotic conditions. Our results demonstrate the importance of considering ontogeny as well as mechanistic responses in evaluating sensitivity to environmental stressors in estuarine species of high conservation concern.

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CONNECTING THE ABUNDANCE OF ESTUARINE MACROFAUNA IN NEARSHORE HABITATS TO LAND USE AND SHORELINE ALTERATION: A CROSS-SYSTEM COMPARISON OF CHESAPEAKE SUBESTUARIES AND DELAWARE COASTAL BAYS

Watershed land use is often associated with patterns in freshwater biota, but examples from coastal marine systems are limited. There is also great interest in the effects of shoreline alteration on estuarine communities. We examined watershed land use and shoreline habitat as predictors of community composition and abundance of nearshore aquatic macrofauna (fish and crabs) in Chesapeake subestuaries and Delaware coastal bays. Data on commonly occurring species were compiled from 648 sites from 45 watersheds that spanned key land use gradients. Land use around each subestuary was assessed at the watershed scale and the riparian scale (within 100m from shore). Separate analyses (generalized linear mixed models) were conducted for gradients of crop and developed land, which strongly co-varied. Forested land use, shoreline habitat, salinity, and subestaury area and depth were also considered in all models. We found multiple significant relationships between species-specific abundance and land use that generally followed established patterns between land use, nutrient enrichment, and water quality. For example, blue crab abundance was negatively related to % cropland and % developed land at both watershed and riparian scales. There was also a negative relationship between % cropland and the abundance of striped bass and spot (watershed scale) as well as hogchoker and fish richness (riparian scale). % forested land (watershed scale) was positively related with the abundance of six species. Shoreline habitat also had major effects on aquatic macrofauna. Littoral prey fishes were associated with marshes, while planktivorous prey fishes were associated with beaches. Conversely, larger bodied species dominated communities at ripraps and bulkheads, which lacked crucial shallow water refuge habitat. These patterns suggest that human land use practices and policies regulating shoreline alteration affect estuarine macrofauna and the ecosystem services they provide.

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EFFECTS OF HYPOSALINITY ON PHOTOSYNTHESIS, RESPIRATION, AND ION CONCENTRATION ON THE SEAGRASS HALODULE WRIGHTII ASCHERS. (SHOAL GRASS) IN A MICROCOSM STUDY

Climate change studies predict greater frequency and duration of storms accompanied by increases in precipitation and subsequent hyposalinity events in estuaries. Photosynthesis and respiration rates were assessed on three dates in shoal grass (Halodule wrightii) in a microcosm study at salinities of 5, 15, 25, and 35 psu over an eight-week period. There was sufficient variability within treatments in net photosynthesis to make a clear pattern difficult to ascertain ($p > 0.05$). Generally, the lower salinity treatments exhibited greatest production rates (0.7 to 1.5 µg O2 mg-1 dw leaf hr-1) later in the study period. Leaf respiration tended to be significantly greater ($p = 0.001$) earlier in the study in lower salinity treatments. Rhizome-root respiration rates were consistently greater (31 to 72%) in lower salinity treatments at all sample dates compared to the treatment at 35 psu, but decreased in all treatments through time ($p<0.001$). Leaf production rates were not significantly different across salinity treatments, but closely followed production trends in the lowest treatment. By the end of the experiment many leaves in the 5 psu treatment were yellowed and shoot density had noticeably decreased. The greater production found in the 5 psu treatment could be an attempt by these plants to compensate for increased respiratory rates in both leaf and below-sediment tissues.

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LONG-TERM PHYTOPLANTON DYNAMICS IN THE NORTH SEA: DYNAMICS OF KEY SPECIES AND NEW ARRIVALS

In this presentation we will show results of comparisons of long-term dynamics in diatoms in the North Sea from two of the longest and most detailed time series in the world: the Helgoland Roads plankton time series (with additional data from the Helgoland transect time series) and the SAHFOS plankton recorder survey data. The abundance of total diatoms has shown a strong increase in both data sets in the late 1990s. Based on this general trend we report different patterns of shifts in abundance and seasonality that have been observed at the species and genus level and we will place these in the context of the prevailing environmental conditions. The species Guinardia delicatula for instance has abruptly extended its seasonal appearance at Helgoland Roads around 1977 but did not signicantly increase in abundance. The presentation will continue with a description of the dynamics of the bipolar centric diatom Mediopyxis helysia that was only formally described in 2006 but has formed massive blooms exceeding 600000 cells L-1 in coastal areas of the Southern North Sea since 2009. This provides a unique opportunity for the study of the early stages of the establishment of a new species in a recipient community based on time series analyses. Joint analyses of the SAHFOS and Helgoland Roads data have shown that this species indeed seems to be restricted to coastal waters. Additionally, growth experiments coupled with field data for the German Bight have confirmed that this species grows fastest at salinities of below 30. Only with this multidisciplinary approach of time series analyses coupled with experimental, including molecular, studies will it be possible to assess the potential long-term impact of this new arrival within the pelagic foodweb of the North Sea.

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SURFACE ELEVATION CHANGE IN CREATED MANGROVES ALONG A 20-YEAR CHRONOSEQUENCE IN TAMPA BAY, FLORIDA, USA: A PRELIMINARY ANALYSIS

Mangroves protect coastlines, provide faunal habitat, and can store large quantities of carbon (C) belowground. However, the accumulation and permanency of soil C on created sites will be dependent in part on the response of new mangrove communities to sea-level rise. We document change in soil surface elevation, vertical accretion, and shallow subsidence on 9 created mangrove sites across a 20-year chronosequence over two years of development, and compare these to an equal number of natural mangrove sites. Vertical accretion and soil surface elevation change ranged from 3.7-6.8 mm/year and 3.4-10.8 mm/year, respectively, among all sites. Sites of moderate age (restored in 1998-2005), having a mix of young mangroves and marsh plants, tended to have greater soil surface elevation gain than very young sites. This may have been promoted by greater root zone expansion as the two community types mixed. Soil surface elevation on the older sites (restored in 1990-1996) declined, which was likely due to a greater rate of subsidence. Older sites also had the most developed surface soils (0-10 cm) in terms of higher C and lower bulk density, which may indicate enhanced potential for compaction. Subsidence was documented in all but one natural reference site, which maintained similar bulk densities to the oldest restored site. While restored and natural mangroves have an ostensible ability to promote surface elevation adjustment, the processes that control soil surface elevation can switch rapidly as sites develop and forests mature. Understanding these changes will promote a better mix of management to promote soil surface elevation change, permanency of soil C stores, and other ecosystem goods and services.

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AVOIDANCE OF PILE-DRIVING NOISE BY STURGEON IN THE HUDSON RIVER ESTUARY: SCIENCE TO INFORM RESOURCE MANAGEMENT

Little is known about the effects of underwater noise on fishes, limiting our ability to effectively assess the impacts of anthropogenic noise on fish populations. Currently, resource managers in the U.S. use two interim noise-exposure criteria to evaluate the onset of potential effects (e.g., hematoma) on fishes: 206 dB re 1μPa peak sound pressure level (SPLpeak) and 187 dB re 1μPa2-s cumulative sound exposure level (SELcum). SPLpeak is a measure of instantaneous noise exposure, while SELcum may require prolonged exposure and assumes fish remain in ensonifed areas during pile driving. As part of a pile demonstration for the New NY Bridge at Tappan Zee, acoustically-tagged sturgeon were monitored in the vicinity of construction activities to assess their response to pile-driving noise. Results showed that fewer sturgeon were detected, and those detected stayed in the area for a shorter period of time, during pile driving than during silent control periods. Moreover, the short amount of time spent by sturgeon in the vicinity of pile driving suggests that those sturgeon were unlikely to have reached the cumulative criterion. These results support the view that sturgeon are likely to avoid impact pile-driving and not remain nearby long enough to experience physiological effects. Thus, this study provides empirical evidence that the SPLpeak criterion is a better metric than SELcum for assessing the potential impacts of pile-driving noise on sturgeon and probably other fish species in the project vicinity.

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WATER QUALITY BENEFITS OF TIDAL FRESHWATER MUSSELS IN DELAWARE ESTUARY

North American freshwater mussels continue to attract conservation and restoration attention because of their declining biodiversity and abundance, utility for bioassessment, and ecological importance. Like their marine counterparts, freshwater mussels are filter-feeding bivalves that process large water volumes, remove particles, and increase light for benthic producers. To understand their potential water quality benefits in the tidal freshwater area of the Delaware Estuary, physiological data were integrated with recent species diversity, size class and abundance data for shallow sub-tidal areas between Trenton, NJ, and Philadelphia, PA. The spatial extent, density and richness of mussels varied widely among four representative beds, and with depth and substrate conditions. A maximum of 6 species and 129 mussels were found in a single 1-meter squared quadrat. Based on RTK-GPS mapping, we estimate that the 3.8 hectares surveyed contain >680,000 mussels having over 1 metric ton of (dry) tissue. Known physiological rates were scaled to body size to estimate that these mussels typically clear >6 million gallons of river water and filter 8.4 metric tons of (dry) suspended solids per day. Many additional mussel beds were not surveyed, including deeper areas. Although vastly depleted in non-tidal streams and rivers, the extant population of native freshwater mussels in the tidal estuary is therefore of sufficient size to furnish valuable ecosystem services of regional significance. Investments in mussel restoration have the potential to boost bivalve carrying capacity and increase ecosystem services, thereby aiding managers in addressing water quality targets for the Delaware River Basin. A diversified, watershed-wide approach to restoring bivalve shellfish (both commercial and noncommercial species, marine and freshwater) has the greatest potential to help improve water quality, including TSS and particulate nutrient reduction.

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COMPARISON OF COASTAL WETLAND CONDITION AMONG SUB-WATERSHEDS OF THE DELAWARE ESTUARY THAT WERE ASSESSED WITH THE MID-ATLANTIC TIDAL RAPID ASSESSMENT METHOD

The Delaware Estuary is a wetland-fringed system with a broad salinity gradient and a diverse array of historic and current anthropogenic stressors. The system is currently losing more than an acre per day of these important coastal wetlands. Prior to loss, coastal wetlands often show impaired health (e.g. sparse canopy density, low belowground biomass). As part of the Mid-Atlantic Coastal Wetland Assessment (MACWA), beginning in 2010 we used the Mid-Atlantic Tidal Rapid Assessment Method (Mid-TRAM v.3) to examine buffer, hydrology, habitat and shoreline condition at nearly 200 random sites, concentrated in representative sub-watersheds around the estuary (~30 points per watershed). For each watershed, we prepared a "report card" that assigns an average grade to that area's coastal wetlands and which describes principal stressor-response relationships (some data were previously reported at CERF. We have now accumulated enough points and watersheds to allow for a comparative analysis among watersheds to deduce some of the most broadly problematic stressors. Stressor-response relationships vary considerably across the system, which stretches from macrotidal freshwater marshes in urban landscapes to microtidal salt marshes along Delaware Bay. Mosquito ditching, filling, hydrological alteration, landward migration blockages, and invasive species are some of the most common stressors. Obstruction of landward migration was found to be the most common cause of low scores. Canopy density (a.k.a. vegetation obstruction) was found to be the simplest and most responsive rapid assessment metric. These comparative data on coastal wetland health and causes of impairment will aid state managers in making informed decisions regarding how best to conserve or sustain the many ecosystem services furnished by coastal marshes in the wetland-dominated Delaware Estuary.

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PUGET SOUND'S REGIONAL WATER QUALITY - SEPARATING REGIONAL AND OCEANIC DRIVERS USING LONG-TERM MARINE MONITORING TIME SERIES

Puget Sound is a large and commercially vital urban fjord in western Washington, USA. Relating water quality to large-scale ocean climate fluctuations has important predictive benefits. From 1999 to 2012 Washington State Dept of Ecology's long-term Puget Sound monitoring data showed significant correlations between temperature, salinity, and dissolved oxygen and three oceanic climate indices: the Pacific Decadal Oscillation, the North Pacific Gyre Oscillation, and the coastal Upwelling Index. Simultaneously, and despite recent improvements in water quality, nutrient concentrations and nutrient ratios have been steadily changing in step with regional population trends. Using multiple time series of monthly observations at 27 core stations throughout Puget Sound, we explore local and regional differences in the relative importance of ocean climate and anthropogenic trends. We hypothesize that regions where ocean climate and anthropogenic forcing have the potential to interact synergistically are likely to experience poor water quality during periods of unfavorable oceanic boundary conditions.

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MEASUREMENTS AND POTENTIAL SIGNIFICANCE OF UREA AS A NITROGEN SOURCE FOR HAB SPECIES IN SAN FRANCISCO BAY, CALIFORNIA: A ONE YEAR PILOT STUDY

Since 1968 the U.S. Geological Survey has maintained a program of research and observation in San Francisco Bay. The program includes measurements of dissolved inorganic nutrients, but organic forms of nutrients including urea are not regularly measured and their concentrations are unknown. Urea is important because it can promote growth and toxicity of harmful algal bloom (HAB) phytoplankton species. We conducted a one-year study of monthly sampling in 2011 to measure urea concentrations at five stations chosen to represent the major sub-embayment of varying hydrography and nutrient chemistry: South Bay, Central Bay, San Pablo Bay, Suisun Bay and the Sacramento River. Each station had maximum urea concentrations in February. The South Bay, Central Bay and San Pablo Bay stations saw urea concentrations above a threshold (1.5 μM) that promotes growth of some HAB-forming dinoflagellates and flagellates. South Bay concentrations exceeded the threshold in December, February, August, and September (1.5 - 2.5 μM) and maintained the greatest overall mean concentration (1.3 μM). Samples were above the threshold in Central Bay in January and February (1.7 and 3.0 μM respectively) and San Pablo Bay in February (2.0 μM); both stations sustained low values during the other months (0.1- 1.2 μM). The Suisun Bay and Sacramento River stations always had low concentrations (0.2-1.3 μM). Based on previous studies and these new findings, we conclude that urea is a potentially significant nitrogen source for phytoplankton in marine-influenced regions of San Francisco Bay. The urea concentrations measured in South Bay, Central Bay and San Pablo Bay are comparable to those seen in research linking urea to HAB species. These results warrant inclusion of urea in monitoring programs and further studies to identify the sources of urea in San Francisco Bay.

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APPLICATION OF A MARINE DEBRIS REPORTING SYSTEM TO TARGET REMOVAL EFFORTS ALONG THE FLORIDA KEYS REEF TRACT

The Florida Keys Reef Tract (FKRT) is a system of benthic habitats from Key Biscayne to the Dry Tortugas. In 2002, the National Oceanic and Atmospheric Administration Southeast Fisheries Science Center's diver-based Reef Visual Census (RVC) began collecting information on submerged marine debris along the FKRT. This study aimed to; 1.) Analyze RVC data for types of debris and spatial distribution; 2) Determine the viability of using RVC marine debris data to target removal; and 3.) Conduct removals at proposed 'hot-spots' and determine debris impact on benthic invertebrates. RVC data identified 1,028 points of marine debris through 2010. Sixty-four percent of all debris was classified as "Trap", 20% as "Fishing", and the remaining 16% as "Other". Mapping of the database with Geographic Information Systems (GIS) determined locations of high marine debris observation density in Biscayne National Park. Nine 'Debris' sites, where debris was listed as present on RVC surveys, and 10 'Control' sites, where debris was not listed as present on RVC surveys, within the Biscayne Bay 'hot-spot' were selected for sampling. Two SCUBA divers conducted surveys using the roving diver technique. Debris was present at all sites, with no difference in debris density between 'Debris' and 'Control' sites. 'Trap' debris was the most prevalent type, accounting for 68% of all debris, and was the most damaging to benthic invertebrates. Soft corals were the most commonly damaged, accounting for 41% of all injuries. The marine debris 'hot-spot' adjacent to Biscayne Bay was verified, but the presence of debris at 'Control' sites suggests RVC data underestimated the extent of debris within the study area. A lack of difference in debris densities between 'Debris' and 'Control' sites indicate RVC data may not be useful in site selection for removal on a fine scale, but this and similar reporting systems may be helping in targeting removals and assessing debris types over time.

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BENTHIC MACROFAUNA AND ECOSYSTEM FUNCTIONING IN THE SHALLOW ESTUARY ODENSE FJORD, DENMARK

This presentation describes a regime shift in dominating benthic macrofauna and associated changes in benthic flora, microbial processes and water chemistry. The abundance of the two native polychaetes, Nereis diversicolor and Arenicola marina and the invasive polychaete Marenzelleria viridis in Odense Fjord, Denmark has been followed at selected stations fjord-wide for at least 20 years. A marked change occurred 10-15 years ago when M. viridis arrived and, together with A. marina, subsequently expanded everywhere in fjord at the expense of N. diversicolor. Eelgrass, Zostera marina, declined and the seagrass, Ruppia maritima, expanded simultaneously. All these changes occurred while the former eutrophic fjord went through a marked oligotrophication process. The three involved polychaetes have strong, specific and partly opposing impacts on microbial processes in the sediment driven by their bioturbation activities (particle reworking and burrow ventilation). A. marina is a "conveyor belt" reworker and populations can annually mix sediments homogeneously down to 30-40 cm depth. N. diversicolor has vigorous burrow ventilation and populations can per m2 pump more than 5000 liter water into burrows every day. M. viridis has much lower reworking and ventilation capacity, but is known to stimulate subsurface sulfate reduction considerably. The different impact of the three polychaete species on sediment biogeochemistry was evident from the water chemistry in Odense Fjord. For example, ammonium and nitrate levels increased when the regime shift from N. diversicolor to A. marina dominance occurred, which reflected that A. marina stimulates the removal of organic matter and release of ammonium and nitrate, while N. diversicolor enhances removal of nitrate through denitrification. Known effects of these polychaetes on sediment biogeochemistry are in this presentation used to discuss and evaluate the wider impact of the regime shift on ecosystem functioning in Odense Fjord.

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TEMPERATURE DETERMINES THE VULNERABILITY OF MUSSELS TO OCEAN ACIDIFICATION

Ocean acidification (OA) is occurring across a backdrop of concurrent environmental changes, from increasing hypoxia to sea surface warming, that are likely to influence species responses to OA. Temperature, in particular, plays a fundamental role in biological processes and has the potential to both offset and exacerbate the effects of OA. While initial studies have examined the combined effects of warming and OA for a narrow range of climate change scenarios, there is a limited understanding of how the effects of OA vary across the much wider and ecologically relevant range of temperatures that organisms experience in the field. Here, we test how OA affects the growth of juvenile bay mussels, *Mytilus galloprovincialis*, across a range of temperatures that encompasses their thermal optimum. Mussels were exposed in the laboratory to a factorial combination of low and high pCO_2 (385 and 1200 ppm $CO_{2(atm)}$, respectively) and temperatures (12, 14, 16, 18, 20, and 24°C) for one month. Results indicate that the effects of OA on mussel growth are highly dependent on temperature. High pCO_2 significantly reduced mussel growth in cool temperatures (14°C), indicating that juvenile *M. galloprovincialis* are potentially vulnerable to OA. However, this effect (i.e., reduced growth in high pCO_2) gradually lessened with successive warming to 20°C, thereby highlighting how moderate warming can mediate the effects of OA through temperature's effect on both physiology and seawater geochemistry. At the lowest and highest temperatures (12 and 24°C), we did not detect an effect of pCO_2 on mussel growth, which indicates that temperature is the key factor driving growth at the edges of the thermal tolerance range. Together, these results highlight the importance of considering ecologically relevant temperatures and climate change scenarios when interpreting species vulnerability to OA.

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EATING BETWEEN THE LINES: FUNCTIONAL FEEDING RESPONSE OF BONNETHEADS (*SPHYRNA TIBURO*)

Large, mobile predators can have strong influences in the structuring of food webs. Few quantitative estimates of the effects of predation by large-bodied consumers exist but are necessary to evaluate their impact on benthic prey species. Numerous economically important species are prey for upper level predators (i.e. smaller sharks and rays) and quantifying predation rates is important both on an ecological and economic level. Measuring a predator's functional response provides quantitative information on the potential for predators to regulate local prey populations and community structure. We examined the functional response of bonnetheads *(Sphyrna tiburo)* to one of its few natural prey items brown shrimp *(Farfantepenaeus aztecus)*. We simulated natural conditions in flow-through outdoor mesocosms and offered live prey at varying densities to quantify functional response of bonnetheads. Bonnetheads consumed prey proportionally across all prey densities and demonstrated a response that lied in between a type I (R^2 =0.847, $p < 0.01$) and type II (R^2 =0.877, $p < 0.01$) functional response. Based on Akaike information criterion (AIC), bonnethead consumption rates fit nearly equally to both the linear regression (AIC= 39.32) and nonlinear regression (AIC= 39.33) models. We fit our data into a generalized functional response model in which the parameter β dictates the type of response. From this equation, β=0.2, which also lies between a type I (β=0) and type II (β=1) functional response. Based on these data, bonnetheads display what most closely represents a type I functional response. Our data show that not all organisms fit within the predefined categories of functional response. As an alternative to strictly typing functional response, we suggest that it be viewed as a continuum based on the estimates of β in the generalized functional response equation in order to achieve a more accurate depiction of feeding rates of a predator to changing prey densities.

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EFFECT OF CHEMICAL AND PHYSICAL CUES ON THE METAMORPHOSIS OF THE AMERICAN HORSESHOE CRAB *LIMULUS POLYPHEMUS*

In many marine invertebrates, metamorphosis is the change from a free-living developmental stage to a morphologically, and often physiologically, different juvenile stage. A decrease in the time to metamorphosis (TTM) occurs when a suitable habitat is detected through

positive chemical or physical cues. Negative chemical and physical cues can delay metamorphosis (or increase TTM). Delaying metamorphosis is considered energetically costly and can limit survival through physiological stress and increased predation. We used *Limulus polyphemus* trilobite larvae to determine the effect of different chemical and physical cues on metamorphosis. Trials consisted of placing individual trilobite larvae into compartmentalized plastic containers. Each compartment contained 40 ml of either control offshore water or treatment water. Treatment water included: (1) different concentrations of *L. polyphemus* and *Halodule wrightii* chemical cues; (2) chemical cues exposed to varying thermal regimes (boiling or freezing); or (3) live physical cues (*H. wrightii*) or artificial physical cues (ribbon and glass rods). We also investigated the costs of delaying metamorphosis (survival and TTM) through the third juvenile stage. The results indicate that the TTM of trilobite larvae decreases with increasing chemical cue concentrations and that the inducing molecule from each chemical cue is thermally stable. Additionally, we show that trilobite larvae respond with a decrease in TTM when exposed to physical structure, and that delaying metamorphosis has no effect on survivorship or TTM after the first juvenile stage. These results indicate the importance of physical structure in the horseshoe crab life cycle, which may play a critical role in the conservation of the species.

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DEVELOPING A PROGRAM FOR SENTINEL MONITORING OF CLIMATE CHANGE IN AN URBAN ESTUARY

Understanding and adapting to climate change has become a critical science and management issue in estuaries worldwide. With this in mind, the Long Island Sound (LIS) Study's management committee commissioned a Sentinel Monitoring for Climate Change workgroup (SMWG) in 2009 to address the localized impacts of climate change. The primary goals of the SMWG are to develop a dynamic monitoring program to identify the effects of climate change on the various ecosystems of LIS, identify climate change sentinels to provide early warnings of impacts and facilitate timely management responses, and ultimately to develop management strategies for adaptation and resilience of LIS habitats and resources where possible. To these ends, the SMWG developed a strategy document outlining key attributes of a sentinel and identified 17 priority and 37 candidate sentinels for the LIS ecosystem. To facilitate communication and outreach, the SMWG has developed a website and a searchable data citation clearinghouse with links to all known LIS sentinel related data sets and local researchers. To date, the SMWG has funded two pilot monitoring programs and a data synthesis grant. The process used by our program is serving as a model for larger regional efforts. We will discuss the preliminary results of these efforts as well as lessons learned and future directions for our program.

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SAN FRANCISCO BAY ACTS AS A RESERVOIR AND MIXING BOWL FOR BOTH MARINE AND FRESHWATER HARMFUL ALGAL TOXINS

San Francisco Bay is a nutrient-enriched estuary that has apparently resisted classic symptoms of eutrophication, such as high phytoplankton biomass and low dissolved oxygen. Recent observations indicate that SFB's resistance to high nutrient loads is weakening, and that conditions are trending toward increased productivity and potential impairment along multiple pathways. A special case within the larger framework of phytoplankton biomass and community composition are those organisms classified as harmful algal blooms. Increases in HABs provide perhaps the most direct metric of ecosystem health since presence of the algae and associated toxins is a clear indication of impairment. Despite the persistent nutrient enriched status of San Francisco Bay, few harmful algal blooms have been reported recently for the estuary. A lack of monitoring may play a role, given the large number of potentially harmful algae present in San Francisco Bay. Given the prevalence of HAB organisms in the Bay, the dramatic increase in blooms of Microcystis, and the potential linkages between ecosystem health and HABs it would be prudent to more closely monitor HAB organisms within San Francisco Bay as an indicator of water quality. Here we provide an overview of results from a pilot program deploying Solid Phase Adsorption Toxin Tracking (SPATT) in conjunction with targeted sampling within both the Sacramento-San Joaquin Delta and SFB Estuary. SPATT spatially and/or temporally integrates toxin concentrations present in the dissolved phase, and frequently identifies the presence of algal toxins missed by traditional grab sampling. We demonstrate the frequent occurrence of marine toxins (particularly domoic acid) interleaving with freshwater toxins (microcystins), along the estuarine salinity gradient, demonstrating the potential for SFB to act as a retentive reservoir for both marine and freshwater toxins, potentially magnifying the impact of HABs in this highly productive ecosystem.

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MODELLING THE INFLUENCE OF GEOMETRIC AND BATHYMETRIC CHANGES ON TIDAL DYNAMICS IN ESTUARIES

The bathymetry and geometry of many estuaries has changed dramatically over the last few decades, both by anthropogenic interventions and natural causes. Examples of bathymetric changes are the deepening of navigation channels and the transformation of multi-channel systems into single channel systems. Land reclamation and construction of retention basins are examples of geometric changes. Since these changes are often implemented simultaneously, it is difficult to assess the effect of separate changes. For example, in the Ems estuary the main channel was deepened, land was reclaimed and the two-channel system has almost disappeared. The combined effect of these changes has resulted in an increase of the mean tidal range by 1.75 m at the head of the estuary, and a dramatic increase in SPM concentration. In this presentation, we will systematically study the influence of bathymetric and geometric changes on the tidal characteristics and the residual circulation in funnel-shaped estuaries. To understand the isolated effect of these changes, a three-dimensional, idealized hydrodynamic model has been developed. This model, which is an extension of the model presented by Winant (2007, 2008), captures the main hydrodynamics (the residual flow and M2 + M4 tidal constituents) for arbitrary geometry and bathymetry. The effects of the various measures on the water motion, and their sensitivity to parameters, will be explained and their relative importance will be discussed. In particular, for the Ems estuary it is found that both the river deepening and the disappearance of the two channel system had a significant influence on the tidal range at the head of the estuary and the tidal velocities in the landward part of the system.

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MODELING THE EFFECT OF HARD CLAM (*MERCENARIA MERCENARIA*) AQUACULTURE ON SYSTEM-LEVEL PROCESSES WITHIN CHERRYSTONE INLET, VA

With the recent growth of the hard clam aquaculture industry, sites of intensive aquaculture have emerged as large-scale agro-ecosystems where the success of aquaculture production is dynamically linked to the health of the ecosystem. Large scale clam aquaculture operations are associated with a range of potential positive and negative feedbacks relating to carrying capacity, nutrient dynamics, water and sediment quality, and proliferation of macroalgae. Quantitative modeling tools are needed to support system-level planning related to site selection, scale of operations, production capacity and ecosystem health. We are developing a modeling tool for Cherrystone Inlet, VA, where one-third (1.9 km2) of the sub-tidal bottom area is held as 37 separate, private shellfish leases with an estimated 100-200 million cultured clams. A reduced complexity estuarine ecosystem model has been coupled with an existing hard clam energetics and growth model and a watershed loading model. The model will facilitate ecosystem-based management and enable regional spatial planning in the full ecosystem context, through coupled simulations of aquaculture activities, land-use changes, nutrient loading, climate change, and estuarine response. Model simulations of current clam densities associated with aquaculture operations in Cherrystone Inlet will be presented and are expected to be at or beyond the ecological carrying capacity, with further increases in clam densities resulting in reduced growth rates. Model evaluations will determine if an intermediate clam population density exists at which growth rates are optimally balanced with minimal impacts to the ecosystem. The complete model will be served as an online tool for use by local managers and industry personnel.

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REDUCED COASTAL STORM IMPACTS THROUGH THE INTEGRATED OCEAN OBSERVING SYSTEM

Extreme weather events cause loss of life and billions in damage. During Superstorm Sandy, IOOS data products helped emergency managers prepare to protect lives and property, and enabled scientists to better understand the storm's track, intensity and the resulting storm surge. However, consistently accurate forecasts of hurricane and extratropical storm intensity

remain elusive, with little improvement over the past 20 years. Recent extreme events reflect the need for enhancement of the nation's observing and forecasting capabilities to meet the growing need for accurate predictions of impacts. The most timely and effective pathway toward better national hurricane intensity forecasting is by integrating the expertise, diversity, agility, and strength of the ocean observing and modeling capabilities of the IOOS regional partnerships on the East Coast, Gulf of Mexico, and Caribbean Sea. The IOOS regional association partnerships have the capability to immediately deploy observing platforms and develop improved data streams and models in support of National Weather Service forecasts. The integrated regional real-time data-assimilation forecast models would significantly enhance the accuracy of the national hurricane and surge forecasts coming from NWS. Specific enhancements include: Filling gaps in operational hurricane monitoring, including the National Glider Network and Depth-Resolving Ocean Buoy Network; Upgrading coastal observing networks; Developing improved regional-scale ocean forecast models; and Establishing a suite of complementary, coupled, real-time, ocean-atmosphere, forecast models. We must strengthen elements of the current system to improve the nation's forecasting capabilities and to provide more timely and accurate information for coastal and emergency managers. This is necessary in the North Atlantic Storm Pathway, as well as across our nation, where storms and extreme events of varying type and strength affect our economy and well-being.

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EFFECT OF DIFFERENT NATURAL DIETS ON GROWTH AND CELLULAR HEALTH STATUS OF CAPTIVE JUVENILE *TACHYPLEUS TRIDENTATUS* (LEACH, 1819)

Research on the optimization for growth performance of juvenile horseshoe crabs under laboratory culture has been studied over the past three decades. However, most such studies are focused on the survival and growth of horseshoe crabs, but the effects on the health status of cultured juveniles are less addressed. In this study, common aquaculture food, brine shrimp Artemia salina and other three types of natural food of horseshoe crabs (clam Ruditapes philippinarum, polychaete Marphysa sp. and a mixed diet of R. philippinarum and Marphysa sp.) were provided to 8th instar Tachypleus tridentatus for 12 weeks in the laboratory to evaluate their growth performance and cellular health status. At the end of the experiment, cumulative molting rate, body weight and specific growth rate for juveniles reared in clam treatment (66.67%, 6.49 g/ind., 0.76%) were significantly higher than that in brine shrimp treatment (33.34%, 4.75 g/ind., 0.32%). The polychaete diet and the mixed diet of clam and polychaete showed varying results in terms of the above parameters. In contrast, the biochemical and cellular properties of haemolymph in the cultured juveniles did no differ among treatments, regardless of the diet types and dietary protein levels. However, the general decrease of hemocyanin concentration and a shift in amebocyte morphology in all treatments during the experimental period indicated that the immune competence of juvenile horseshoe crabs can be adversely affected by captivity induced stress.

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RESPONSE OF EMBRYONIC MARKET SQUID, *DORYTEUTHIS OPALESCENS*, TO OXYGEN, PH AND PCO_2 FROM UPWELLING MARGIN ENVIRONMENTS

Market squid, *Doryteuthis opalescens*, is commercially and ecologically important to the nearshore California Current Ecosystem. Encapsulated squid embryos are site-attached to the seafloor, develop using a limited energy source (yolk), and can simultaneously exposed to near-hypoxic and high pCO_2 (low-pH) environments on a regular basis. To understand whether these factors might be driving growth rate and yolk utilization response, we used a laboratory approach to compare effect(s) of each single-factor (i.e. high pCO_2 v. low dissolved oxygen (DO)). We hypothesize that low-levels of pH and DO are independent stressors during squid embryogenesis. Specifically, we hypothesize that exposure to (a) low-levels of pH causes embryos to deplete yolk stores prior to hatching, and (b) low-levels of DO causes metabolic suppression. To test these hypotheses, squid embryos were chronically exposed to each factor independently: pCO_2=1,350.8 µatm (pH=7.56), and DO=83.6 µatm. Half of the embryos were randomly selected and removed after 27 days of exposure and the other half after 32 days. Squid embyros were analyzed using photo-microscopy, and ImageJ software. We categorized embryonic stages using developmental signposts based on allometry (head width: dorsal mantle length) and calculated growth and yolk utilization rates. Standardizing by the development signposts revealed that embryos exposed to low-pH had faster growth and yolk utilization rates than embryos exposed to low-DO. Further, the yolk utilization rate indicates that prior to hatching the external yolk will be completely depleted for low-pH group, signifying that the later stages may be most affected. Embryos in the low DO group did not show conclusive negative effects from exposure. Future comparisons of these single factor treatments to multiple factors (low DO and pH) and no factor (i.e control) treatments will further elucidate these results.

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OYSTER REEF RESTORATION IN THE NORTHERN GULF OF MEXICO: EXTENT, METHODS AND OUTCOMES

Shellfish reef restoration to support ecological services has become more common in recent decades, driven by increasing awareness of the functional decline of shellfish systems. Maximizing restoration benefits and increasing efficiency of shellfish restoration activities would greatly benefit from understanding and measurement of system responses to management activities. This project (1) compiles a database of nGoM inshore artificial oyster reefs created for restoration purposes including critical planning, location and construction data, and (2) quantitatively assesses a subset of reefs to determine project outcomes. From Nueces River, TX to Apalachicola, FL, we documented 260 artificial inshore reefs created for ecological restoration. Information on reef material, reef design and monitoring was located for 93, 43 and 13 % of the reefs identified. Of reefs with available information, 52% were created using rock substrate, and 20% using shell. Project costs and monitoring information were available for very few reefs (< 15% of projects). To quantify restoration success, we used diver surveys to quantitatively sample oyster density and substrate volume of 11 created reefs (7 with rock; 4 with shell), paired with 7 historic reefs. Reefs were defined as fully successful if there were live oysters, and partially successful if there was hard substrate. Of these created reefs, 73% were fully successful, while 82% were partially successful. Total volume of structure and adult oyster densities were higher on rock reefs than on historic or shell reefs, but spat density was highest on historic reefs, and lowest on shell reefs. These data highlight the need to track reef restoration projects, including information on material and reef design in order to better separate material and reef design effects on reef outcomes.

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ECOSYSTEM BASED MANAGEMENT OF HUMAN ACTIVITIES – AN EXAMPLE OF SEAGRASS MANAGEMENT ON THE WEST COAST OF SWEDEN

The objective set in the European Union (EU) Marine Strategy Framework Directive (2008/56/EC), is to reach a good marine environmental status by 2020. EU member states are required by the directive to apply an ecosystem based approach for managing human activities and to develop and implement strategies for how to protect marine environment, prohibit further degradation and, where practicable, to restore damaged ecosystems. A non-degradation policy affects the possibility to further exploit and economically develop an area. In Sweden the non-degradation policy has initiated a discussion to use compensatory mitigation as a means to allow further development. As an example, developers wanting to expand or to build new marinas in areas of valuable eelgrass (Zostera marina) have suggested compensatory measures as a condition for a permit. The problem however is that there is no clear policy for how to compensate for a loss of biodiversity in general, or harm or risk for harm to a particular species. Neither is the technical knowledge about how to actually transplant eelgrass on a new location sufficient. In an interdisciplinary research program we are addressing both the lack of scientifically based knowledge and how this knowledge can be used effectively once it is available. We focus on eelgrass management on the west coast of Sweden as an example of how science can be incorporated into legal decisions. Eelgrass was chosen as it provides many important ecosystem functions and as we have seen a big loss (about 60 %) of this habitat in the last decades. This degradation is primarily caused by euthrophicaiton but coastal development is also a threat to the remaining eelgrass beds. In this paper we present the main requirements of the Marine Strategy Framework Directive and discuss how the implementation of it will affect the possibility of further economic development in coastal areas, as well as how to compensate for damage made.

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MODELING THE EFFECTS OF HYPOXIA ON FISH MOVEMENT IN THE GULF OF MEXICO HYPOXIC ZONE

One of the world's largest areas (up to 22,000 square km) of seasonal, coastal hypoxia occurs in the northern Gulf of Mexico off the Louisiana coast. Hypoxia can affect

fish through direct mortality, altered movement, increased susceptibility to predation, reduced habitat, changes to food resources, and decreased fecundity. Atlantic croaker (Micropogonias undulatus), a common benthic fish in the Gulf hypoxic zone, is a good model organism to study the effects of hypoxia on fish. Croaker movement was modeled in a simple test grid and in a larger coupled hydrodynamic-water quality model using two different behavioral movement approaches: event-based and kinesis. The coupled model consisted of a high-resolution, three-dimensional, unstructured-grid Finite Volume Coastal Ocean Model (FVCOM) and a revised version of the Water Quality Analysis Simulation Program (WASP). Simulated dissolved oxygen concentrations (DO) and temperature values for 2002 were used to determine the quality of the model cells, which acted as a movement cue. Quality was low in cells with DO less than 2.0 mg/l and higher as the temperature approached the optimal value of 27 C. Our initial simulation results suggest that the degree of avoidance built into the movement algorithm plays a major role in affecting exposures, regardless of which behavioral algorithm is used, and that the time histories of individual-level exposures are complicated and difficult to capture with examination of the average fish.

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SUPPORTING THE SPINELESS: CREATING A BACKBONE TO AN UNDERGRADUATE LEARNING EXPERIENCE WITH INVERTEBRATES AND BEYOND

Research suggests undergraduate students learn more effectively through an integration of highly diverse group activities and guided independent study. Here we present a case study wherein an Invertebrate Zoology course was re-structured to include: interactive reading guides, peer-led paper review, peer-led literature discussion, group integration of invertebrate species concept maps, high and low stakes writing and field activities utilizing different research vessels. Effort was also made to integrate multiple disciplines (e.g. art department), into course content. Knowledge of both course content in addition to critical thinking, problem solving skills and mastery of fundamentals for field research were assessed during pre-trip preparation activities, field activities and post-trip reflection assignments, which included data analysis and completion of a naturalist journal. For many of the upper-level undergraduate students, this was their first exposure to these types of activities and assessments designed to generate learning. Overall, there was a marked increase in writing skills, confidence in mediation and leadership skills in addition to increases in knowledge of course content and STEM concepts. We provide information on the general outline of this course as well as specific examples which can be easily incorporated into many undergraduate courses. Select students within this course continued onto a PI-guided research project over the Summer 2013 term, in which they were highly successful when compared to undergraduates who did not have preparation for lab and field work through the Invertebrate Zoology (or any similar) course. In light of the increasingly competitive nature of graduate school and job applications, particularly with American education policies designed to increase student achievement and participation in STEM fields, we feel the aspects found within this course model provide an edge not otherwise found in traditional courses.

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QUANTITATIVE ASSESSMENT OF CARBON STOCKS IN SEAGRASS BEDS OF ABU DHABI, UNITED ARAB EMIRATES

'Blue Carbon' is a growing field of research which aims to document organic carbon stocks found in vegetated coastal ecosystems, such as mangrove and seagrass bed sediments, in order to estimate their role in carbon sequestration. Research is lacking which advances our understanding of carbon stocks in a hypersaline-hyperarid climate and the potential influence of these factors on carbon sink potential. In cooperation with the Abu Dhabi Environmental Data Initiative (AGEDI), with support from Environment Agency – Abu Dhabi (EAD) and led by GRID-Arendal, The United Arab Emirates (UAE) Blue Carbon Project goals were to map the spatial and regional variability of seagrass beds and then quantitatively assess carbon stocks along the Arabian Gulf coastline in order improve knowledge of carbon sequestration in this poorly studied region. In May 2013, soil cores up to 1 m deep were taken at eighteen sites, sampled at 3 cm depth intervals, and processed for organic and inorganic carbon content. Seagrass and macroalgae abundance, diversity and biomass data were collected and recorded at each site. Seagrass beds consisted of *Halodule uninervis*, *Halophila ovalis* and *Halophila stipulacea* while macroalgae consisted mainly of *Avrainvillea*. Organic matter content of the soil samples ranged from 1.6-20 %, and bulk density of the soil ranged from 0.7 – 1.8 g cm3. In most the samples, carbon stores were dominated by inorganic carbonates. Our first estimates of carbon storage in seagrass soils are between 12.3 and 240.8 Mg C ha-1. The highest C stores were associated with one protected site with fine-grained, deep sediments, with C density comparable to some of the most C-dense subtropical beds; however, carbon stocks in the majority of the cores were modest compared to other subtropical locations.This research will add to a growing dataset on carbon stocks and support the role that seagrass beds play in the carbon storage capacity of coastal environments.

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WAVE ATTENUATION BY THE EELGRASS *ZOSTERA MARINA* AND ITS DEPENDENCE ON WAVE ENERGY

Prevention or reduction of coastal erosion through wave damping is often cited as an ecological benefit of submerged aquatic vegetation such as eelgrass, but the effectiveness of this process over a range of wave heights and periods is not well quantified. We investigated wave attenuation by the eelgrass *Zostera marina* just north of Possession Point on Whidbey Island, Puget Sound, Washington USA (tide range 3.5 m). The eelgrass meadow extended about 150 m cross-shore, from 0 to -4 m MLLW, leaf length averaged 0.55 m, and leaf area index was 1.7 m^2/m^2. We collected high-frequency velocity and pressure data from February 28 to March 21, 2007 at two sites: within the canopy and in a naturally occurring break (about 200 m wide) in the vegetation. Wave energy at the site is relatively high for eelgrass habitats: maximum significant wave height (H_s) exceeded 0.6 m, and during three events H_s exceeded 0.3 m for more than 6 hours. Representative wave periods were 2-4 s. Wave heights within the eelgrass meadow (approximately 100 m from the edge) were reduced by approximately 50% compared to the unvegetated site. At the same time, the reduction of wave orbital velocity averaged only 16%, at 0.45 m above the sea floor, indicating that the influence of the canopy on bed shear stress was much less than on wave height. Within the canopy (0.25 m above the sea floor), vertical wave velocities were damped much more than horizontal wave velocities. We characterize the effect of eelgrass on waves through a drag coefficient C_d (Mendez and Losada, Coastal Engineering, 2004). In our study, wave height attenuation decreased with increasing H_s, consistent with published findings that C_d is inversely related to Reynolds number *Re*. We test whether the reported C_d- *Re* relationship extends to the maximum H_s we measured, which is greater than wave heights in previous studies of wave attenuation by eelgrass, and thus more relevant to predicting the response to storm conditions.

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"WHO'S A SCIENTIST?" PROJECT (WASP): INSIGHTS INTO MIDDLE AND HIGH SCHOOL STUDENTS' PERCEPTIONS OF THEMSELVES AS FUTURE SCIENTISTS

Between 2009 and 2011, Virginia Institute of Marine Science NSF GK-12 "PERFECT" fellows implemented a before-and-after Draw-a-Scientist Test (DAST) survey in local middle and high school classrooms. The study was conducted to investigate students' perception of science and scientists after weekly interaction with their "Scientist in Residence" classroom fellow. The results from these surveys displayed compelling trends related to the personal characteristics, type of research, and the location and gender of the scientist, which illustrated a strong influence from the individual fellow acting as a resident scientist. These findings further intrigued and ultimately inspired the fellows to investigate how the students would imagine themselves as scientists rather than what they stereotypically envisioned as a scientist. The fellows designed a new and innovative survey to focus more attention on the type of science that personally captured each student's attention. For example, what type of science would they study, what type of education would they need, how long would this take, why they would or would not want to be this scientist, and what their dream job currently is. To investigate this question, the fellows retooled their modified Draw-a-Scientist Test to create the Who's A Scientist Project (WASP) Survey. Our analyses once again focuses on comparing student responses both before and after exposure to their "Scientist in Residence". Additionally, the NSF GK-12 fellows highlight some of the contrasting responses between when students were asked to draw a "scientist" (DAST), versus when they were asked to draw themselves as a scientist (WASP). Finally, we draw from this data to gain further insight into an apparent disconnect between what the students view as "scientific careers" and what the fellows defined as science careers.

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MODELING THE ECOSYSTEM RESPONSE TO EXTERNAL LOAD REDUCTIONS IN A WARMER CLIMATE: PRIMARY PRODUCTION, NET ECOSYSTEM METABOLISM, AND HYPOXIA

Determining the ecological effects of climate induced warming on coastal marine ecosystems will be complicated within shallow tributary estuaries due to the complex cycling of nutrients and organic matter, diversity of primary producers, enhanced benthic-pelagic coupling, and advection of nutrients, labile organic matter, and hypoxic water from adjacent systems. This study utilized an intermediate complexity eutrophication model developed for the York River estuary (YRE), VA to predict how water column primary production (PP), net ecosystem metabolism (NEM), and hypoxia will change within this sub-estuary of Chesapeake Bay under a range of nutrient loading and warmer climate scenarios. Modeled PP responded positively to a warmer climate in the winter and spring throughout most of the YRE, but decreased in the summer and fall within the lower estuary. NEM was predicted to become more autotrophic in the upper estuary, presumably due to increased rates of nutrient cycling. However, NEM was predicted to decrease in response to higher sediment and water column respirations rates during the spring, summer and fall throughout the rest of the estuary. Warmer temperatures increased the predicted temporal and spatial extent of hypoxia (< 2 mg L-1), with the tributaries experiencing a relatively constant increase in the number of hypoxic days during the late spring and early summer. Low oxygen conditions in the lower estuary increased more rapidly with increasing temperatures. Offsetting this spatial and temporal increase in low oxygen with climatic warming will require additional nutrient and organic matter load reductions from the tributaries, watersheds, and the Chesapeake Bay in order to achieve the same level of improvement predicted in the absence of a warming climate. Model simulations are compared to similar nutrient and climate scenarios for Narragansett Bay, RI and the New River estuary, NC.

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THE USE OF AQUACULTURE TO ENHANCE THE *LIMULUS POLYPHEMUS* POPULATION IN DELAWARE BAY

The New Jersey Aquaculture Innovation Center at Rutgers University has instituted a program to enhance the natural population of Limulus polyphemus in the Delaware Bay Estuary (DBE) by culturing the earliest life history stages when mortality is high and production costs are minimal. Located on the Cape May Canal in southern New Jersey, the AIC pumps both raw and treated (sand filtered, UV sterilized) DBE seawater through the facility. Two experiments were performed that tested aquaculture methodologies which could improve L. polyphemus production efficiency. Eggs of L. polyphemus were collected from local sub-optimal nesting beaches impacted by coastal development and rising sea levels. Eggs were hatched in McDonald-type jars in a re-circulating system that used treated seawater and a header tank to provide constant, controllable flow to each of the jars. We tested the effects of egg stocking density and seawater flow rates on hatching success. The results showed the highest hatching success at higher egg densities with lower flow rates. Trilobites were reared in downweller silos in a raceway tank with flow-through raw seawater. We compared the growth of instars exposed to 2 feed treatments. One treatment fed only on the organic material available in the incoming raw seawater while the other treatment was given a supplement of brine shrimp nauplii. There was no statistically significant difference in growth between feed treatments. At the time the crabs were released to DBE, most were at the 3rd instar stage. Our research demonstrates two aquaculture methodologies for L. polyphemus that improve production efficiency and enhance survival through the most vulnerable life stages. Further development of aquaculture methodologies may promote large-scale efforts to enhance natural populations of horseshoe crabs in DBE and estuaries worldwide. Supported in part with funding from the DuPont Clear Into the Future Program.

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THE EFFECTS OF HARDENED SHORELINES ON SAV IN THE CHESAPEAKE AND MARYLAND COASTAL BAYS

This study is one component of a large-scale, five-year, multi-disciplinary project designed to improve the capability of predicting the combined effects of multiple stressors on habitat quality in Mid-Atlantic estuaries and coastal lagoons. Our portion of the study specifically examines how shoreline type (natural vs. hardened) influences submerged aquatic vegetation (SAV) populations directly offshore. We are assessing the difference in SAV density, biomass, and species composition between natural shorelines and nearby shorelines hardened with rip-rap within approximately 30 sub-estuaries of the Chesapeake and Maryland Coastal Bays. Watershed land-use data is also considered. Preliminary analyses of our transect data indicate that SAV beds adjacent to natural shorelines have higher densities, species richness, and species diversity than those adjacent to shorelines armored with rip-rap. Salinity regime may also play a role in system resilience, as our data suggest that armored shorelines have more negative impact on SAV beds in lower salinity environments than in higher salinity environments. When watershed land-use is taken into account, even at the small scale of our transects, the more developed a watershed becomes, the less SAV it will support.

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THE CHALLENGE OF UNDERSTANDING GLOBAL CHANGE INFLUENCES ON PLANKTON DYNAMICS IN COASTAL MARINE ECOSYSTEMS

The dynamics of a plankton community reflect the combined effects of biological interactions and physical and chemical environment on the biomass and vital rates (growth, reproduction, mortality) of the system's component populations. Whereas open-ocean generalizations about plankton trophic relationships may be sufficient to capture the main trends in community response to global change forcing (e.g. temperature, stratification, acidification), the unique circumstances and assemblages of many coastal ecosystems present major challenges to developing mechanistic and predictive understanding of change. Here, I present some recent results from experimental field and laboratory studies of plankton food-web dynamics with the goal of defining productive directions that coastal studies will need to take to address future challenges.

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ACIDIFICATION IMPACTS GROWTH PER MOLT AND HARDENING TIME OF JUVENILE BLUE CRAB *CALLINECTES SAPIDUS*

Elevation of atmospheric CO2 is decreasing the pH of oceanic and coastal waters. Numerous studies have documented the effects of an acidifying ocean on calcifying organisms such as diatoms and bivalves. However, less work has been done on the impacts of acidification on crustaceans which have more complex and composite exoskeletons. Here we report the effects of acidification on molting in juvenile blue crab Callinectes sapidus. Previous studies have shown that growth per molt in this species is a conservative property and that growth variability arises from differences in the intermolt period. We quantified the impact of acidified conditions on growth per molt in juvenile blue crab using a randomized experiment in which individual crabs were exposed to either ambient or acidified treatments (pH= 6.5 and 7.0 ±0.2). Experimental tanks were set up in a flow through system in which tanks contained filtered Patuxent river water. The pH in each experimental tank was manipulated by controlling a CO2/air stream in header tanks. Our results indicate that growth per molt was considerably reduced in acidified treatments (8.4% at pH 6.5 vs 19.1% under ambient conditions). Moreover, the period required for the new carapace to harden was extended significantly from 0.3d (ambient) to 2.3d (pH 6.5). These results indicate that acidification of the estuarine environment may reduce blue crab growth rates and extend the soft shell phase during which crabs are particularly vulnerable to predation.

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EQUILIBRIUM MORPHOLOGY OF TIDAL CHANNELS

Tidal channels exert a crucial role for morphodynamics of tidal systems. They furnish preferential pathways for flooding and drying of intertidal areas and for the circulation of

sediment and nutrients. Various studies analyzed the evolution and equilibrium configuration of tidal channels, focusing on the dynamics and equilibrium profile of the channel bed for a given channel-width distribution, as well as on the channel equilibrium cross-sectional shape. However, a well founded modelling framework assessing both the altimetric and planimetric equilibrium features of tidal channels is still lacking. The present modelling framework analyzes the equilibrium configuration of a straight, short tidal channel and of the adjacent intertidal platform. We consider a rectangular domain forced by a sinusoidal tide and with a no-flux condition at the landward boundary. The quasi-static hydrodynamic model provides the instantaneous water discharge flowing through any cross section. The local value of the instantaneous bed shear stress within a given transect is computed on the basis of the procedure introduced by Pizzuto (1990). Simulations start from an initially flat bed configuration with a small incision along the longitudinal axis of the domain. Water discharge flowing through any cross section is computed, together with the instantaneous distribution of bed shear stresses, possibly leading to bed erosion. The model is then run until an equilibrium plano-altimetric configuration is asymptotically attained. Different forcings (e.g., sediment supply, rate of sea level rise, tidal range) have been considered. The calculated equilibrium profile nicely agrees with observed profiles, confirming theoretical predictions and the O'Brien-Jarrett-Marchi "law" relating the equilibrium cross-sectional area to tidal prism. Finally, some information is obtained on the dependence of the channel width to depth ratio on the relevant hydrodynamic and morphodynamic parameters.

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OCEAN FORCING OF WEST-COAST ESTUARIES: THE "REACH OF THE OCEAN" IN TERMS OF NUTRIENT AND ACIDIFICATION EFFECTS OF UPWELLED WATERS ON ESTUARY ENVIRONMENTS

Observations of seawater intrusions in San Francisco Bay, Tomales Bay and other west coast estuaries show that newly upwelled waters may intrude significant distances into estuarine basins, delivering pelagic nitrate and potentially exposing estuarine communities to acidification of coastal waters. Classical estuarine literature is more concerned with freshwater forcing and loading, with the ocean playing a supporting role. Recent work along the west coast of the USA shows the importance of ocean forcing and in this paper we use Tomales and San Francisco Bay data to delve deeper into this phenomenon. The importance of seawater intrusions depends on the rate of primary production relative to the rate of seawater intrusion.

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INCREASING ECOLOGICAL UPLIFT USING ECOLOGICAL MODELING IN WETLAND RESTORATION PROJECTS: A NOVEL APPROACH

Federal regulatory compliance under the Clean Water Act stipulates that wetland mitigation must compensate for lost wetland functions. Historically, parties involved in wetland mitigation have used federal- and state-regulated mitigation ratios (acres impacted: acres created) to calculate the extent of restoration required. It is becoming increasingly preferred to determine mitigation requirements based on a comparison of the wetland functions lost due to development and gained due to compensatory restoration. The same analyses that allow practitioners to perform this type of assessment are flexible enough to be used in the planning and design phases of compensatory mitigation of wetlands. We are developing novel ways to apply such analyses to restoration projects. Wetland Functional Assessments (WFAs) can be used in wetland restoration planning and design to maximize the functional provision of restored wetlands and demonstrate to regulators the relationship of restoration attributes to the wetland functions they provide. We illustrate the process of using a specific WFA, the Evaluation of Planned Wetlands (EPW), in wetland restoration to create maximum ecological uplift. The EPW calculates metrics for a series of functions based on wetland characteristics, enabling us to determine uplift for specific functions as well as overall uplift across the site. This allows us to assess which wetland attributes should be enhanced to most effectively maximize wetland function and project uplift. This process is particularly appealing to determine the best approach to restore wetlands with a specific budget and in an urban area where land availability is limited. We introduce this novel technique for maximizing ecosystem function in wetland restoration projects through the case study of a 185-acre remediation and restoration project underway in Woodbridge, New Jersey, and apply our results to the broader context of planning approaches.

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THE APPLICATION OF WEB-BASED DECISION SUPPORT TOOLS FOR VISUALIZING COASTAL FLOODING VULNERABILITIES AND PLANNING FOR RESILIENCY: THE NEW JERSEY EXPERIENCE

While sea level rise is a world-wide phenomenon, mitigating its impacts is a local decision-making challenge that is going to require site-specific remedies. Faced with a variety of conflicting mandates and uncertainty as to appropriate responses, local land use planner and managers need place-based decision support system tools. To address these needs, we developed NJFloodMapper (www.NJFloodMapper.com) to help decision-makers assess the vulnerability of key infrastructure within their communities to sea level rise. Based on initial user surveys, we chose a template developed by the NOAA Coastal Services Center that provided a suite internet-accessible, user-friendly mapping and visualization tools. We have and continue to customize the template to meet our users' identified needs. While NJFloodMapper was initially designed to address the long term effects of sea level rise, as a result of Hurricane Sandy, the tool has been expanded to more fully include storm-related surge. To provide fuller decision support capability, the NJFloodMapper tool is being more closely integrated with the web-based Getting to Resilience community evaluation tool (www.prepareyourcommunitynj.org). In combination, these web-based tools are a key element of an extensive outreach program to local communities to promote enhanced preparedness and land use planning decisions in the face of continued sea level rise and devastating coastal storms.

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NEARSHORE LINKAGES: THE ROLES OF NATIVE OYSTERS AND EELGRASS AS LIVING SHORELINES IN THE SAN FRANCISCO ESTUARY

The San Francisco Bay Living Shorelines: Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. Such habitat features have the potential to positively influence physical processes (such as waves and sediment transport) that determine shoreline morphology. In this project constructed in July 2012, we are further testing restoration methods, restoring eelgrass and oyster habitat, testing the individual and interactive effects of restoration techniques on habitat values, and beginning to evaluate effects on shoreline processes. Plots (32 x 10 m) of oyster substrate alone (shell-bag mounds), eelgrass alone, or the two together in an additive design, are being compared to un-manipulated control plots along the San Rafael shoreline in the first phase of the project. Preliminary data show that restored habitat structure at this site promotes increased abundance of numerous organisms relative to bare sediment, with a number of native invertebrates reproducing on the oyster substrates. Native oysters have recruited in large numbers to the shell bag mounds, particularly on north-facing, vertical, or lower-elevation surfaces that likely minimize thermal stress. Birds such as black oystercatcher and several wader species increased in density at treatment plots in comparison to pre-treatment and control densities. Two large wind-wave events in March and April 2013 led to preliminary findings of reduced waves in plots with added structure at particular water elevations during the tidal cycle. This project will advance our understanding of restoration methodologies with an eye towards habitat creation and shoreline protection in an era of rising seas and increasing storm surges.

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TEMPORAL AND SPATIAL CHANGE IN GRAIN SIZE AND ERODIBILITY ON A MACRO-TIDAL CHANNEL-FLAT COMPLEX IN KINGSPORT, N.S., CANADA, VERSUS A MESO-TIDAL CHANNEL FLAT COMPLEX IN WILLAPA BAY, WASHINGTON, USA

Understanding of sediment texture and erodibility on muddy tidal flats and channels on temporal and spatial scales is required to resolve formative processes and the subsequent transport of sediment in these areas. Recognition of the importance of flocculation to the formation and maintenance of cohesive intertidal deposits has spurred investigations on textural studies of bed sediments, field studies of suspended flocs, and modelling studies. Regional grain size surveys were carried out in September 2008, July 2009, and February 2010, on the muddy meso-tidal flats and channels in the southern end of Willapa Bay, Washington State. Results indicated that floc fraction, the amount of bed sediment deposited as flocs, showed a strong inverse correlation with seabed elevation. No correlation between sediment grain size and distance to the nearest channel could be delineated. Erodibility studies, using a Gust chamber, showed that bottom sediments became more erodible in the tidal channel during winter when suspended sediment concentrations were high in comparison to summer values. In April 2012, a study was initiated to examine the seasonal change in grain size and erodibility on a muddy macro-tidal flat and channel complex in Kingsport, N.S. Sixty samples were collected for bottom sediment grain size analysis every month with 37 from the tidal flat and 23 from a tidal channel and its banks. Erodibility measurements were made monthly with a Gust erosion chamber on duplicate samples from the tidal flat, left and right tidal channel bank, and the channel thalweg. The monthly sampling was completed in March 2013. Results to date suggest that bottom sediment size does correlate with distance to the nearest channel. Erodibility measurements show an annual order of magnitude difference in cumulative mass eroded and may be responsible for the order of magnitude change in suspended sediment concentration in the Upper Bay of Fundy between winter and summer.

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CAN ESTUARINE WETLANDS CONSTRUCTED FOR AQUACULTURE PRODUCTION BE DESIGNED TO PROVIDE A WIDER RANGE OF ECOSYSTEM SERVICES?

Reconversion of either agricultural lands or degraded marshes to wetlands for aquaculture production may be economically attractive in itself but can also be an opportunity to develop wetland designs that can provide a wider range of ecosystem services beyond food production.We studied well-established estuarine constructed wetlands at Veta La Palma, Andalucia, Spain, where over 3000ha of previously-drained marsh have been converted into large (70ha) extensive lagoons for aquaculture production of fish and shrimp. The lagoons provide permanent inundated refuges in a seasonally dry system, with highly benthic and planktonic productivity supporting commercially-important aquatic species and red list species such as eels. The shallow pond design enables their use by wading birds and the aquatic productivity supports very high bird diversity and abundance. This is a key ecosystem service as the wetlands are adjacent to the Doñana National Park, a Ramsar wetland site of international importance, which is a significant transitory area for six million migratory birds and a major overwintering area for more than 500,000 water birds and the most important European wintering site for Anatidae. Nutrient loads are greatly reduced in water passing through the lagoons, which is a further important ecosystem service given the high levels of nutrients in the Guadalquivir estuary.This study demonstrates the effectiveness of well-designed and appropriately-located constructed wetland systems that can meet conservation objectives, in this case support for birds, and at the same time be economically viable aquaculture systems.

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COMPARISON OF SUBSTRATES FOR ST. MARY'S RIVER OYSTER REEF RESTORATION

Over-harvesting, disease, and other anthropogenic impacts have resulted in Chesapeake Bay Eastern Oyster (Crassostrea virginica) population declines. Many oyster restoration efforts have been undertaken, including oyster reef construction. The ideal reef substrate is natural oyster shell. Unfortunately, this material is becoming scarce, and therefore, alternative artificial materials are being explored. This study compared natural and artificial materials for oyster reef construction in the St. Mary's River, St. Mary's City, Maryland. Oyster larvae were set on oyster shell, concrete rubble, and polyvinyl chloride pieces (PVC). After initial settlement in the lab, oyster spat on the three substrates were relocated to the river and monitored for growth and mortality for seven months. Significantly more larvae originally settled on oyster shell than on concrete rubble or PVC. After three months, there was a significant difference between spat abundance on shell and PVC, but there was no significant difference between the spat abundance on oyster shell and concrete. After five months of growth, oyster spat on shell were significantly larger than the spat on the other two substrates. Larval settlement, spat mortality, and spat growth differed between the three substrates, and this suggests that concrete may be an appropriate alternative material for restoration projects.

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NITROGEN UPTAKE KINETICS OF *MICROCYSTIS AERUGINOSA* IN THE SAN FRANCISCO ESTUARY DELTA, CA

In the last decade there has been an apparent increase in frequency and intensity of the harmful cyanobacterial bloom-former Microcystis aeruginosa in the San Francisco Estuary Delta (Delta), the heart of California's water infrastructure. It has been hypothesized that anthropogenic nitrogen, specifically ammonium and urea, may promote these blooms. At present, little is known about which chemical forms of nitrogen are used by M. aeruginosa in the Delta. Nitrogen uptake kinetic experiments with field-collected M. aeruginosa were conducted using four 15N-labeled substrates (nitrate, ammonium, urea and glutamic acid). Maximum biomass-specific uptake rates were highest for ammonium (up to 74.3 x 10-3 h-1) and lowest for glutamic acid (< 2.0 x 10-3 h-1). M. aeruginosa showed preference (i.e. greater uptake) for nitrogen in the following order: ammonium, urea, nitrate, glutamic acid. At present ambient nutrient concentrations in the Delta, M. aeruginosa does not appear to be nutrient-saturated. This suggests the potential for enhanced growth of M. aeruginosa with future increases in nitrogen. Kinetics parameters (Ks and Vmax) obtained from this study were compared to published values for other phytoplankton taxa. The data indicates that M. aeruginosa in the Delta may have a competitive advantage for ammonium uptake over other phytoplankton. The preference by this fairly recent newcomer to the Delta for reduced forms of nitrogen may explain its success in an environment influenced by a growing human population and the accompanying increased anthropogenic nitrogen loading from waste water treatment and agricultural practices.

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DENITRIFICATION IN SAN FRANCISCO BAY: MICROBIAL DIVERSITY, ABUNDANCE, AND ACTIVITY

Denitrification, the microbial conversion of nitrate to gaseous products, is one of the most important processes determining the fate of nitrogen in suboxic and anoxic environments. In San Francisco Bay-Estuary, anthropogenic nutrient inputs are a matter of increasing concern, yet we have a surprisingly poor understanding of denitrification rates and how they are regulated. In addition, the community composition of the denitrifying bacteria themselves is governed by physicochemical parameters in ways that have yet to be fully understood. Our study examined five sites along a salinity gradient from the delta to the central bay, sampling surface sediments monthly, to capture both spatial and seasonal variation in factors such as salinity, temperature, carbon, nitrogen species, and trace metals. Potential denitrification rates were measured using the acetylene block technique. Culture-independent methods targeting the marker genes *nirK* and *nirS* were used to assess denitrifier abundance and diversity. In all sites and all times of year, *nirS*-type denitrifiers were 10- to 1000-fold more abundant than *nirK*-type denitrifiers, and *nirS* gene copy number was correlated to total bacterial abundance. Abundance and community composition of both genes showed marked spatial structure and were significantly correlated to salinity as the strongest determining variable. Denitrification potential rates varied widely with location and season; in general, rates were highest in the central bay. The potential for denitrification in the sediment was frequently limited by the availability of nitrate and sometimes of carbon. These findings

indicate how differently nitrogen-cycling microbial communities behave in different parts of the estuary, with important implications for our understanding of nutrient dynamics in this ecosystem.

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GROWTH AND GENETIC STRUCTURE OF RESTORED *ZOSTERA MARINA* POPULATION ON THE SOUTHERN COAST OF KOREA

Eelgrass, *Zostera marina*, is the most abundant seagrass species on the coasts of Korea, but most large eelgrass meadows have disappeared since the 1970s due to the human-induced disturbances. In this study, eelgrass shoots from Koje Bay were transplanted in Aenggang Bay for restoration of destroyed meadows in this bay system. Shoot morphology, growth, and shoot density were monitored at the transplant site and the adjacent natural eelgrass meadow in Aenggang Bay. Additionally, reproductive patterns were measured at both the transplant and the natural meadows to investigate the reproductive strategy for maintenance and expansion of seagrass bed at the transplant site. Genetic diversity in the transplant population was also estimated to investigate genetic variability after 5 years following transplantation. *Z. marina* shoots transplanted in Aenggang Bay adapted quickly to new environmental condition. Changes in shoot morphology showed that the time required transplant establishment was approximately 8 months. Leaf productivity in the transplant site was also similar to that in the natural meadow after approximately 8 months. Bed expansion via sexual reproduction was not found during the monitoring period, whereas transplant shoots produced lateral shoots via asexual reproduction. Genetic diversity index of the transplant site increased from 0.6 to 0.65 during 5 years after transplantation. Increased genetic diversity at the transplant site in Aenggang Bay implied exchange of genetic materials between the transplant site and the natural populations. Thus, transplantation of eelgrass shoots, which have different genetic structure, may enhance genetic diversity of the eelgrass populations at the transplant sites.

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MONITORING NUTRIENT AND SEDIMENT INPUTS TO TEXAS BAYS AND ESTUARIES: A COMPARISON OF SELECTED HIGH FLOW EVENTS, 2009-13

Since 2009, the U.S. Geological Survey (USGS) has been evaluating the variability of nutrient and sediment characteristics in the lower reaches of the rivers entering Texas bays and estuaries during a variety of hydrologic conditions. Discharge, sediment concentration, sand/fine break, and nutrient concentration data were collected to gain a better understanding of the hydrologic and water-quality characteristics for the coastal ecosystems. Four events of unique hydrologic conditions on the Trinity River entering the Galveston Bay estuary are evaluated to demonstrate the variability of sediment and nutrient characteristics caused by differences in flood-discharge magnitude, duration, origin of floodwater runoff, and timing of sample collection. Some differences in the nature of the sediment and nutrient characteristics of high flow events were evident. These events are also compared to the hydrologic response of the Colorado River entering the Matagorda Bay estuary in Texas during high flow events. Results indicate that it might be possible to better understand the extent of nutrient and sediment loading in Texas bay and estuaries using selected measurements of discrete and continuous water-quality data. Both optical and acoustic methods are evaluated and an apparent correlation was observed with the concentrations of selected nutrients and suspended sediment, and an apparent correlation was observed between suspended sediment and total nutrient concentration measured during these high flow events.

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SEASONAL VARIATION OF PHYTOPLANKTON PRODUCTIVITY IN THE GWANGYANG BAY, SOUTHERN COASTAL SEA OF KOREA

Coastal estuaries and bays have dynamic environmental conditions characterized by freshwater inflows, tides, wind and other episodic events, which make these regions very productive. Using a 13C-15N dual isotope tracer technique, carbon and nitrogen uptake rates of phytoplankton were measured in order to determine seasonal and annual variations and define potential controlling factors for phytoplankton growth in the Gwangyang Bay from October 2011 to October 2012. Based on field measurements in 2011 and 2012, an annual primary production rate of phytoplankton was 137.0 g C m-2 yr-1. One of interesting things in this region is that the mean daily carbon uptake rates of phytoplankton (871.5 mg C m-2 d-1) and the integrated chlorophyll-a concentrations (61.6 mg m-2) were highest among different seasons. Since the Gwangyang Bay is a shallow (< 10m) coastal region generally with a strong mixing condition by tide and wind, the euphotic depths are normally very shallow (< 5m) and limited by relatively low light intensity. Therefore, a strong light condition during the summer period allows the summer phytoplankton bloom, not a spring bloom, in the Gwangyang Bay of Korea.

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SEASONAL AND INTERANNUAL VARIABILITY OF WINTER-SPRING PHYTOPLANKTON IN CHESAPEAKE BAY: 1988-2010

We have examined the seasonal to interannual variability of winter-spring phytoplankton in the mainstream portion of Chesapeake Bay. The analysis is based on the Chesapeake Bay Monitoring Program data collected from 1988 to 2010. There are two seasonal phytoplankton blooms at the surface during spring and summer whereas the bottom chlorophyll-a concentration exhibits strong seasonality with one bloom during spring. The concentration of winter-spring (January-April) chlorophyll-a, a proxy for spring phytoplankton biomass, is associated with the initiation and duration of summer hypoxia in the mid-bay region and related to two independent variables including total nitrogen load driven by river discharge and surface water temperature. Hence, we have examined their links to the climate variability over the bay watershed region. The empirical orthogonal function (EOF) analysis successfully extracted the spatial and temporal information of monthly sea-level pressure (SLP) anomaly for the eastern United States. The first EOF mode of SLP anomaly during fall-early winter (October-December) affects the amount of freshwater into the bay during late fall-early spring (November-March) and the third EOF mode in late fall-winter (November-January) is significantly related with the surface water temperature during winter (December-February). The biomass and abundance of four major phytoplankton groups (i.e., diatoms, dinoflagellates, cryptophytes, and cyanobacteria) above the pycnocline were analyzed to investigate the interannual variability during the winter-spring period. We found that the majority of biomass during the spring bloom period results from diatoms in the mid- and lower-bay whereas dinoflagellates become more dominant species recently in the upper-bay area. It is interesting that phytoplankton has become more abundant after the bay experienced the significant winter drought that occurred from 1999 to 2002.

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THE RELATIVE IMPORTANCE OF VEGETATED AND OPEN WATER PONDS TO CARBON PRODUCTION AND MATERIAL FLUX IN THE FRESHWATER TIDAL WETLAND LIBERTY ISLAND WITHIN SAN FRANCISCO ESTUARY

Relatively abundant native fish in the Liberty Island freshwater tidal wetland suggests this wetland provides habitat and food resources that enhance fishery production in San Francisco Estuary. However, little is known about the environmental conditions, carbon production, material flux and controlling mechanisms within this wetland and the relative importance of large open water versus small vegetated ponds to these processes. Continuous measurements of water quality variables, chlorophyll, phytoplankton yield, suspended solids, salt, light and flow were used to characterize the habitat, carbon production and material flux among wetland ponds in Liberty Island between 2010 and 2011. Daily average chlorophyll a concentration, primary productivity, water temperature, specific conductance, turbidity, soluble reactive phosphorus and dissolved organic nitrogen were greater in small ponds compared with large open water ponds. Small ponds also exported suspended solids, salt, chlorophyll and carbon to adjacent ponds within the wetland. This contrasted with open water ponds which imported material from adjacent channels. Mechanisms differed among ponds with material flux controlled by advective flow in the small ponds and tidal flow in the large open water pond. Despite their small area, small vegetated ponds were important contributors to carbon production and material flux in the wetland.

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PHYTOPLANKTON TRAIT BASED FUNCTIONAL DIVERSITY AS AN INDICATOR FOR STABILITY

Using quantitative phytoplankton data from the northern Baltic Sea, we tested if the trait based functional diversity indicates stability of the community. We used long-term data and did a re-analysis of an existing experimental mesocosm data. Our results showed that the late summer communities with low initial functional diversity and species number were vulnerable to higher variability in change in both functional diversity and species number. This result indicates that high functional diversity and species number could predict stability in the community. Using trait based functional diversity instead of species number is a more robust method since counting functional diversity is not as dependent on time used for analyzing a sample, or the species-level identification skills of the microscopist. Our results showed that trait based functional diversity could be used as an indicator to predict how vulnerable the community is to environmental changes.

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A COLLABORATIVE TRANSDICIPLINARY APPROACH TO URBAN STORMWATER

The collaborative transdisciplinary approach to environmental issues, using Community Based Participatory Research (CBPR) principles, has been shown to complement local regulations to promote more responsive and effective environmental management (Owens, 2000; Margerum, 2008). Despite this information we still have a poor scientific and practical understanding of this approach in shaping stormwater management within urban watersheds (Kootz and Moore Johnson, 2004). The integration of CBPR with a cutting edge Diagnostic Decision Support Tool (DDSS) is an innovative transdisciplinary approach to improve urban stormwater conditions (quantity and quality) by increasing Best Management Practice (BMP) adoption, specifically on targeted hotspots. A Diagnosis Decision Support System (DDSS), incorporating the adoption model, will be developed, calibrated and validated to target hot spots, prescribe appropriate BMPs for them and map the level of change in social factors, attitudes and behaviors (adoption barriers) needed for adoption. Various social science tools, including semi-structured interviews, PhotoVoice, economic assessments, and surveys of residents from two diverse and contrasting watersheds in Maryland and the District of Columbia that drain to the Chesapeake Bay were used to explore BMP adoption barriers. CBPR instruments, including Watershed Steward Academies (WSA) train-the-trainer program, social marketing and education programs, and technology transfer, will be applied in cooperative partnership with three state agencies and five well-established grassroots and community associations active in the study watersheds to lower BMP adoption thresholds and implement prescribed BMPs in hot spots.

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OYSTER FILTRATION VERSUS PASSIVE STRUCTURAL IMPACTS OF *CRASSOSTREA VIRGINICA* REEFS ON REMOVAL OF PARTICULATES

Over the last two decades the eastern oyster (*Crassostrea virginica*) has received increased attention due to declining abundances and recognition of the ecosystem services they provide. An important impact of oyster reefs is the removal of particulates from the overlying water column. A number of field studies have estimated filtration as the removal of suspended solids (TSS) and phytoplankton (Chl a) as water passes over *C. virginica* reefs. A majority of these studies indicate that there is more material being removed from the water column than would be predicted by oyster filtration rates alone, suggesting the possibility of loss due to other filter feeders and to oyster structure. The physical structure of the reef could impact particulate sedimentation through hydrodynamic changes related to the physical structure of the reef. The main objective of this study is to determine the amount of removal that is directly due to oyster filtration through measures of total loss and loss through oyster filtration activity and passive sedimentation. Loss of particulates in water traveling over a reef will be calculated from upstream/downstream water sampling for Chl a and TSS and will be compared to the oyster filtration rate calculated from the total production and percent inorganics of the biodeposits on four medium reefs located in southeastern North Carolina. Flow velocities and sedimentation rates will be measured on each reef in order to provide information on the physical processes taking place on the reef. Mussels of the species *Brachidontes exustus* and *Geukensia demissa* are the only other significant filter feeder present on the study reefs and will be accounted for in analyses. An experimental manipulation will also be conducted to evaluate removal rates before and after oyster defaunation. This study will lead to a better understanding of how filtration and hydrodynamic factors interact to remove suspended particulates in dynamic intertidal estuarine systems.

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APPROACHES TO UNDERSTANDING AND MEETING THE NEEDS OF DECISION MAKERS IN THE CAROLINAS

The Coastal Ocean Research Monitoring Program (CORMP), a sub-regional component of the Southeast Coastal Ocean Regional Association (SECOORA) and the larger NOAA Integrated Ocean Observing System (IOOS), collects marine and environmental information in the coastal waters of North Carolina and South Carolina. Established in 1999 through funding provided by NOAA Coastal Services Center and subsequently IOOS, CORMP has provided near real-time and non-real time information as well as products designed to support decision makers in the region. CORMP has worked with federal, state, and local decision making entities such as NOAA's National Weather Service, U.S. Marine Corps Base Camp LeJeune, North Carolina Department of Environment and Natural Resources - Division of Marine Fisheries, City of Durham, NC, and the Cape Fear River Basin Monitoring Program. This presentation will highlight approaches to understanding decision maker science needs using a variety of stakeholder engagement strategies (e.g. workshops, surveys, networking) and best practices that foster on-going stakeholder investment and feedback. Lastly, this presentation will examine the influence that political and economic factors have had on CORMP's efforts to provide science-based products designed to inform decision maker needs.

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EFFECT OF TIDES ON MOUTH BAR MORPHOLOGY AND HYDRODYNAMICS

Mouth bars are morphological units important for deltas, estuaries or rivers debouching into the sea. Several processes affect their formation. Herein, we focus on the role of tides on shaping mouth bars, presenting both hydrodynamic and morphodynamic results. The effect of tides is analyzed in two end-member configurations: a river with a small tidal discharge compared to the fluvial discharge (fluvial dominated), and a river with very large tidal discharge (tidal dominated). Mouth bars formation is analyzed by means of the coupled hydrodynamic and morphodynamic model Delft3D. The presence of tides affects the hydrodynamics of the jet exiting the river mouth. The resulting velocity field is characterized by residual currents influencing the growth and the final shape of mouth bars. Our analysis shows that tides promote mouth bars widening. Moreover, a large tidal discharge leads to the formation of a central channel typical of tidal inlets. Simulations indicate that mouth deposits are characterized by the presence of two channels for negligible tidal discharge, whereas three principal channels are present in the tidal dominated case. Based on our numerical analyses we present a robust criterion for the occurrence of mouth deposits with three channels. Trifurcations form when the tidal discharge is large with respect to the fluvial one and the tidal amplitude is small compared to the water depth. Finally, predicted mouth bar morphologies are compared with good agreement to river mouths in the Gulf of Mexico, USA.

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VARIATION IN BENTHIC MACROFAUNAL ASSEMBLAGES IN MULTISPECIFIC SEAGRASS MEADOWS IN THE SOUTHERN PHILIPPINES: EFFECTS OF DIFFERENT SEAGRASS SPECIES ON EPIFAUNA AND INFAUNA

Although the role of seagrasses on enhancing diversity and abundance of associated fauna is generally well-understood, the effect of different seagrass species on benthic epifauna and infaunal assemblages is often overlooked. To examine whether benthic epifauna and infauna assemblage patterns vary among vegetation with different dominant seagrass species, we carried out a quantitative comparisons of species richness, abundance and assemblage structures among three seagrass vegetation types, *Cymodocea rotundata*, *Enhalus acoroides* and *Thalassia hemprichii*, in Lopez Jaena, Misamis Occidental, southern Philippines. The *Cymodocea* vegetation was characterized by higher seagrass shoot density and lower seagrass biomass compared to vegetatations dominated by *Enhalus* and *Thalassia*. A total

of 30 and 15 species of epifauna and infauna were found with an average density of 104 and 49 individuals/0.0314m^2, respectively. Abundance and species richness did not vary significantly among the three vegetation types for both epifauna and infauna. Neither did similarity of the benthic macrofaunal assemblages differ significantly among seagrass vegetation types. Results of multivariate analyses relating assemblage structure and abiotic/biotic environmental factors showed that the above-ground biomass of seagrasses can explain most of the observed variation in epifaunal community across sites (42% explained variance), whereas none of the selected environmental variables was found significant to result to variation of infaunal community pattern. The study demonstrates that dominant seagrass species cannot be good predictor of associated macrofaunal abundance and biodiversity pattern, and that response to seagrass biomass and structure differs between epifauna and infauna. KEY WORDS: Abundance, Biodiversity, Epifauna, Gradient analysis, Infauna, Lopez Jaena, Philippines, Macrobenthos, Plant-animal interaction, Tropical seagrasses

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THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM (NERRS) SENTINEL SITE PROGRAM. HIGHLIGHTS AND LESSONS LEARNED FROM A SUBSET OF CURRENTLY "OPERATIONAL" NERRS SENTINEL SITES

To be an operational participant in the National Estuarine Research Reserve Sentinel Site Program (NERRS SSP) for determining effects of changing water levels and inundation on coastal habitats, research reserves must maintain specialized observational infrastructure and have the programmatic capability outlined in the NERRS Sentinel Sites Program Guidance Plan. The systematic implementation of consistent standards across diverse ecological regimes provides an opportunity to explore more efficient ways to conduct long-term monitoring related to specific climate change stressors. This presentation will focus on the efforts of Reserves who have achieved "operational" NERRS sentinel site status through the connection of long term coastal habitat monitoring infrastructure (such as vegetation monitoring and associated Surface Elevation Tables (SETs) currently being collected through the System Wide Monitoring Program (SWMP)) to local high accuracy vertical control networks connected to the National Spatial Reference System (NSRS) and long-term high accuracy water level information. The ongoing evolution of monitoring and analysis techniques at the reserves serves as a contribution to the field of environmental monitoring and will provide support for regional and national data syntheses and modeling efforts. This presentation will highlight some of the major accomplishments and lessons learned at a subset of research reserves including issues related to bringing high levels of accuracy into "challenging" coastal environments, data processing and management, and providing stakeholders with the information needed to prepare for and develop strategies to address sea level change impacts on coastal habitats. There will be a discussion of some of the common challenges and barriers to implementation, and current efforts to alleviate those barriers through strategic partnerships, research, tool development (or capacity building), and targeted training.

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SPATIAL AND TEMPORAL VARIATIONS IN BIOGEOCHEMICAL FLUXES BETWEEN A LATERAL EMBAYMENT AND THE COLUMBIA RIVER ESTUARY CHANNEL

The goal of this study is to utilize long-term time series measurements of currents and biogeochemical concentrations (e.g., methane, DO, CDOM, Fl, and total P) to quantify net fluxes of these quantities between an intertidal embayment and the main channel of the Columbia River estuary and the variability of these fluxes with variations in forcing, based on a correlation analysis between concentrations and currents between the bay and the estuary. In addition we use tidal-cycle shipboard transects, along the border between the embayment and the Columbia River channel, to quantify spatial variability in these biogeochemical fluxes. The lateral embayment studied was Cathlamet Bay, a large intertidal embayment at the landward end of the Columbia estuary salt wedge. Field studies span the spring freshet to the minimum in river discharge in late fall of 2012. A major result of this study is that during late summer, the bay is a significant source of methane to the estuary.

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SOCIO-ECONOMIC ASSESSMENT AND COASTAL MARSH RESILIENCE ON THE CHESAPEAKE BAY

Changing climatic conditions and accelerated sea-level rise in the mid-Atlantic U.S. pose a threat to the resiliency of coastal communities, and increase their overall physical and socio-economic vulnerabilities. Communities, such as those of the Deal Island Peninsula on the Eastern Shore of the Chesapeake Bay estuary in Maryland, are in need of being integrated into coastal and marsh resource decision-making. In the face of sea-level rise and changing ecosystem services, stakeholder involvement in resilience and adaptation planning must compliment their cultural heritage if successful implementation and a sense of ownership are to be achieved. In this study, socio-economic analysis of a culturally rich coastal community is being performed as part of a larger socio-ecological project funded by the NERRS Science Collaborative. The goals of the socio-ecological study are to 1) enhance stakeholder collaboration and elicit local knowledge on the values and perceptions of the Deal Island socio-ecological system (SES), 2) integrate the ecological and human dimensions within the SES, 3) develop cultural models for socio-ecological services and resilience, as well as measure their degree of consensus, 4) establish a benefit/risk characterization, and 5) establish a value ranking process to ensure appropriate management approaches. Goals will be achieved through the implementation of three Collaborative Research Projects, focusing on the themes of marsh restoration, flooding, and heritage. The methodologies employed will take the nature of a collaborative learning approach, where specific methods are from the fields of anthropology and ecological economics, with the addition of integrating qualitative and quantitative project results within a geospatial framework. In this presentation, discussion topics will include preliminary socio-economic results and challenges, as well as science communication tools that have been implemented and tested through the project.

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DEVELOPING NUMERIC NUTRIENT CRITERIA FOR SOUTHWEST FLORIDA TIDAL CREEKS

The three contiguous SW Florida National Estuary Programs (Tampa Bay, Sarasota Bay and Charlotte Harbor) recently developed numeric nutrient criteria (NNC) for their respective estuaries that were adopted by the USEPA and FDEP. Through the NNC development process it became clear that, while NNC were being developed for freshwater, estuarine and coastal systems, tidal creeks serve distinct ecological roles as areas of high productivity and as nursery habitats for estuarine and coastal fish species. As such, we recommended to state and Federal regulators that tidal creeks have their own water quality standards to protect and support aquatic life in these systems. We proposed to develop and execute protocols for the establishment of water quality standards for tidal creeks in SW Florida in order to provide protection and restoration targets for these critical ecological resources. We identified over 300 tidal creeks within SW Florida estuaries. We refined several conceptual models (stressor-response, watershed management and conceptual ecological models) and identified forcing functions, drivers and mediating effects for their applicability to tidal creeks. Existing hydrographic, watershed, water quality and biological information was evaluated to assist in creek selection for sampling. We developed a method to classify creeks according to watershed characteristics and in-stream habitat features to arrive at a sampling matrix of sixteen creeks that represented the range of creeks found in SW Florida. With assistance from six county partners, sampling will begin this fall and will include

water quality (nutrients, chlorophyll, turbidity, DO, etc.), biology (fisheries, hyperbenthos, vegetation), and hydrology (stream flow, tides). Data will be analyzed with the objective of developing a tool/framework that can be applied to developing NNC for SW Florida tidal creeks. Proposed NNC will also include a methodology for implementation and compliance assessment.

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HERE TODAY, GONE TOMORROW: A SPATIO-TEMPORAL FRAMEWORK FOR EVALUATING ECOLOGICAL CONSEQUENCES OF EXPANDING COASTAL HYPOXIA ON UPWELLING MARGINS

Rising CO2 in the atmosphere leads to warmer, more stratified oceans and reduced ventilation, but also leads to intensified upwelling along eastern Boundary Currents, causing expansion of the world's oxygen minimum and oxygen limited zones (OMZs; OLZs). As a result, upwelling margins are experiencing increased coastal hypoxia and hypercapnia. However, the strong natural variability of O2 on multiple time scales, and its close linkage with pCO2 pose a challenge for understanding ecosystem responses to OMZ expansion off California and in other upwelling regions. This talk will offer a spatio-temporal framework within which to view various forms of ecosystem response to hypoxia and their functional consequences. Semidiurnal, diurnal, event-scale, seasonal, interannual, and decadal-scale fluctuations and secular trends in oxygen concentration and pH each will induce different levels and types of influence on species and ecosystems. Depending on duration of exposure to hypoxia and hypercapnia, changes in ecosystem structure may result from avoidance behavior by fish and crustaceans, and from selection for small body size, opportunistic life histories, surficial feeding modes and lifestyles among more sessile benthic invertebrates. Through these influences, hypoxia alters emergent properties of ecosystems such as spatial heterogeneity, phenology, connectivity, biodiversity, trophic complexity, and resilience. The extent to which ecosystem services and functions are compromised or enhanced depends on the time, spatial scale and dimension examined. This talk will explore consequences for fisheries production, food web support, habitat provision, nutrient cycling, and carbon sequestration.

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THE EUTROPHICATION FIX: NITROGEN EXTRACTION POTENTIAL OF OYSTERS IN URBAN AND SUBURBAN CONTEXTS

Oysters are commonly given credit for the potential to extract nutrients from eutrophic waters. An estimate of benefits of bivalve restoration requires an understanding of the extraction efficiency with special attention paid to the question of whether bivalves will be removed as a resource or whether regulations even allow such removal for commercial consumption. We compare results from the major urban Jamaica Bay with the Suburban Great South Bay, south shore of Long Island, New York. Both were once great commercial oyster grounds. Jamaica Bay has an annual nitrogen input from wastewater plants of 5.8x10^6kg N yr^(-1), whereas Great South Bay has an input from variable sources of 8.5x10^5 kg N yr^(-1). We estimated nitrogen removal potential by measuring nitrogen content of tissue and shell. We used an aquaculture model, involving coverage of half the bottom with aquaculture cages. Using an ambitious restoration plan of 5000 acres (78 percent of Jamaica Bay), 1.4 x 10^10 oysters can remove 47 percent of the N input, assuming an aquaculture. The recovery, however, would be prohibitively expensive and New York State regulations would preclude human consumption. 5000 acres in Great South Bay planted in oysters would remove 148 percent of the nitrogen, and ca. 100 percent removal would be achievable with a realistic 3000 acres, which is a target for the Long Island town of Islip. Oysters would be harvestable for market. A problem might be a spatial mismatch between patches of high productivity and the location of the oyster aquaculture grounds. Our results suggest that an aquaculture-based system can have a significant impact on nitrogen inputs in suburban bays and should be one justification for an aquaculture-removal scheme. On the other hand, oysters cannot solve our problems in an economically feasible manner in a heavily nitrogen-impacted urban bay.

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FACTORS AFFECTING THE IMPACT OF *AMPITHOE VALIDA* ON SAN FRANCISCO BAY EELGRASS RESTORATION

There is a growing interest in restoration of eelgrass (Zostera marina) in San Francisco Bay. One potential issue effecting the success of restoration projects is herbivory by the gammarid amphipod Ampithoe valida on early stage eelgrass restoration plantings. Using mesocosm experiments, field experiments, and feeding choice experiments, we examined the direct and indirect effects of five common San Francisco Bay mesograzers on eelgrass mass and length, the potential for assembly order to influence damage to eelgrass from A. valida, the effect of eelgrass donor source on mesograzer recruitment, the effect of eelgrass donor source on A. valida feeding preferences, and the role that concentration of phenolic compounds in eelgrass plays in these interactions. Results of these experiments show that mesograzer species differ in their effects on eelgrass, with species having either a positive, negative, or neutral effect on eelgrass biomass. Results also demonstrated that, in mesocosms, the presence of the native isopod Idotea resecata reduces herbivory by A. valida, that, in the field, A. valida recruits to one donor source in greater abundance than another, and that, in the lab A. valida preferentially feeds on eelgrass from one donor source over others. The role which phenolic compounds play in these interactions remains unclear. The capacity of I. resecata presence and choice of eelgrass donor source to reduce herbivory by A. valida on eelgrass restoration plantings may provide tools for reducing the impact of A. valida on eelgrass restoration in San Francisco Bay.

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WINTER STORM INDUCED BAY OSCILLATIONS IN A WESTERN LOUISIANA ESTUARINE LAKE AND ADJACENT WETLAND

Calcasieu Lake estuary is connected to the Calcasieu River in the north and the Gulf of Mexico in the south. Unlike the estuarine bays of southeastern Louisiana, Calcasieu Lake and other estuaries of the Chenier Plain are not rimmed by a chain of barrier islands, and their connection with the coastal ocean is constricted through narrow channels, which has significant implications for the hydrodynamic processes at work. Astronomical tides in the area are weak, and wind is the main force driving bay oscillations. Winter storms occur frequently in Louisiana as roughly bimodal processes: wet and warm southerly winds are replaced by stronger northerly winds with dryer air and lower temperature, preceded by a low pressure trough cold front with precipitation. Meteorological conditions seem to control bay flushing. In an effort to understand how meteorological events affect the flushing and oscillation of the bay-wetland system, we deployed numerous sensor packages in open water, wetland, and ship channel locations to gather meteorological and oceanographic information since 2011. We also used data from LADNR for the adjacent wetland. The long-term data allowed us to consider the winter storm impact for the whole season. Studies of this area are limited, and even tidal harmonics are unreliable due to a lack of data and analysis. Tidal harmonics for tidal elevation and velocity from our analysis further confirm that the astronomical tide is fairly small and irregular due to the mixture of semi-diurnal and diurnal tides. Our analysis verifies that the energy of the bay oscillation is dominated by winter storms, and tidal energy is only a fraction of that. The bay oscillation is largely synchronized, and any seiches are small during normal winter storms. Strong stratification of the estuary, especially in the deep channel, can occur because of low energy in tidal stirring and mixing. However, winter storms can vertically mix the water column.

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ISOTOPE CONSTRAINTS ON PARTICULATE ORGANIC CARBON SOURCE AND BIOGEOCHEMICAL PROCESS IN THE EAST CHINA SEA

Particulate Organic Carbon (POC) as well as its stable carbon (δ13CPOC) isotopic ratio were determined on suspended matter collected from the Changjiang River and ECS during summer period in 2009. The δ13CPOC values showed rather normal range from -25.9 ‰ to -18.5 ‰, with an average of -24.4 ‰. In combination with the horizontal gradient of seawater density, Suspended Particulate Matter (SPM), Chl-a and δ13CPOC ratios indicated that the terrigenous material was dominated in the Changjiang River and estuary, while phytoplankton produced POC was the main source of organic matter eastern of front. It is noteworthy that a negative correlation betweenδ13CPOC and the dissolved CO2 concentration in surface waters eastern of front was observed, which suggested the compound-specific carbon isotopic composition of sedimentary organic matter maybe a good proxy to reconstruct the paleo-pCO2. However, this phenomenon reminds us more carefully to apply two end member of δ 13CPOC value to calculating organic matter sources in the marginal sea.

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LIGHT LIMITATION OF PRIMARY PRODUCTIVITY IN THE HIGH-NUTRIENT, LOW-CHLOROPHYLL A EAST RIVER TIDAL STRAIT, NEW YORK CITY, NEW YORK

The East River tidal strait is located in a highly-urban and industrial section of New York City. We studied a site in close proximity to one of New York City's largest wastewater treatment plants, the Hunts Point Wastewater Treatment Plant, which discharges 378-757 million liters of tertiary-treated effluent per day. Chlorophyll a at the site ranged 1-2 μg L-1, an order of magnitude lower than the 10-yr average value of >10 μg L-1 in western Long Island Sound during the April-October study period. Dissolved inorganic nitrogen ranged from 20-70 μM. There was no evidence of the seasonal cycle typical of Long Island Sound, in which high concentrations of dissolved nutrients observed in winter are depleted in spring and summer months. Dissolved oxygen in the water varied only slightly between day (~ 4 mg L-1) and night (~ 3 mg L-1) in the summer, indicating low photosynthetic activity. The estimated phytoplankton productivity on a sunny summer day in the top 0.5 m depth was approximately 0.28 mg C m-1 h-1 based upon in situ irradiance and fluorometry measurements. We tested the hypothesis that the low chlorophyll a and low phytoplankton productivity were attributable to limitation by light (rather than nutrients, as in most coastal areas) caused by extremely high suspended sediment loads (TSS = 21 ± 10.1 mg L-1, ~ 80% of which were inorganic materials). Experiments employing light manipulation and variable fluorescence fluorometry with the Fire (Fluorescence Induction and Relaxation System by Satlantic) were performed. The photosynthetic variable maximum electron transport rate (ETRmax) increased 20% to 120% when water samples were incubated under elevated irradiance (100 to 200% of the in situ irradiance). The results indicated primary productivity in this high-nutrient, high-turbidity coastal environment was light limited.

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YOU ARE WHAT YOU EAT: DETERMINING THE ZOOPLANKTON FATTY ACID COMPOSITION IN WESTERN ALBEMARLE SOUND AND CHOWAN RIVER, NORTH CAROLINA

River herring (Alosa pseudoharengus and A. aestivalis) stocks have failed to recover over the last century and two potential reasons for this lack of recovery may be low larval survival rate due to a lack of zooplankton prey and/or inadequate nutrition derived from zooplankton prey. We investigated these hypotheses in the western Albemarle Sound and Chowan River, North Carolina by measuring zooplankton abundance, community composition, and fatty acid composition during spring and summer 2013. In April, the larger sized zooplankton (60-200 μm) were primarily represented by Cyclopoida, and Bosmina spp. The upper river sites had a fatty acid signature dominated by α-linolenic and stearidonic acids. In May, the zooplankton community was dominated by Acartia spp. in the sound and lower reaches of the river, with a transition at the up river sites to Leptodora kindtii. As salinity increased, the fatty acid signature consisted of docosahexaenoic (DHA) and eicosapentaenoic (EPA) acids. In June, the down river sites were dominated by Leptodora kindtii and copepods, and the upper river sites by smaller cladoceran species. Leptodora kindtii fatty acid signature was dominated by high EPA and a decrease in DHA. The fatty acid signature of copepods had an EPA/DHA ratio of one, which represents omnivorous feeding, and smaller cladoceran had higher palmitoleic acid, representing herbivory. Small sized zooplankton (< 60 μm) at all locations, over all months were a mixture of copepod nauplii and rotifers. We found that zooplankton fatty acid composition was tightly coupled to species composition and was correlated to sampling time and salinity, even when abundances were similar. A salinity intrusion event in May dramatically shifted the fatty acid composition of the zooplankton community, but was short-lived. This suggests that the diet conditions experienced by river herring may change rapidly, impacting survival and growth of river herring over short time periods.

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IMPLICATIONS FOR THE FUTURE OF FISHERIES AS EXTRACTIVE INDUSTRIES IN THE CREATION OF SUSTAINABLE PLACES: A CASE STUDY OF SEAGRASS MEADOWS IN THE TURKS AND CAICOS ISLANDS

Seagrass meadows are important marine ecosystems that are in worldwide decline. Seagrass meadows are suggested to play an important role, both as valuable nursery habitat for juvenile fish species as well as a key foraging ground for adults. The mangrove-seagrass-reef continuum is now understood to be a holistic ecosystem with seagrass meadows making a significant contribution to reef fisheries stock. However, evidence of this remains limited in many parts of the world. This research considers the role of reef and lagoon seagrass meadows in the Turks and Caicos Islands in contributing to fisheries productivity, by investigating the relationship of ecological survey data to fisheries catch, and coupled socio-ecological links. Seagrass meadow assemblages were surveyed during the summer 2013 period both during the day and at night. Sites were chosen that represented "Lagoon" meadows and "Reef" meadows. Meadows were surveyed using a variety of techniques (timed-swims, fyke netting and seine netting) to triangulate data and establish robust representations of species assemblages. Species type, size and number were recorded and the data gathered elicited some important relationships between seagrass meadows and species habitat use. This was supported by data accessed and reviewed from local fisheries. Specifically key fisheries (e.g. Grouper, Conch, Grunt) in the Turks and Caicos Islands contributing to major export products and local food supply are supported by seagrass meadows. Our research raises some important questions about the sustainability of seagrass meadows in the face of environmental destruction and the viability of local food security in the islands.

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SOUNDSCAPES AND SETTLEMENT: HABITAT-RELATED SOUND AS A CUE FOR LARVAL OYSTERS

The underwater soundscape is emerging as a potentially rich source of sensory information for marine fish and invertebrates, but the habitat-related sound patterns and organism responses remain largely uncharacterized. Auditory reception may be especially useful during larval settlement and habitat selection, as sound is transmitted large distances compared to other cues, and reflects the bio-physical characteristics of source habitats. Oyster reef soundscapes are of particular interest because reefs are patchily distributed, productive estuarine and coastal habitats that harbor many sound-producing organisms (e.g. sciaenid fish, snapping shrimp). To examine the spatiotemporal variability in acoustic characteristics of these habitats, we used stationary and drifting hydrophone-recording surveys at sub-tidal oyster reserves and soft-bottoms throughout Pamlico Sound, NC. Data show that reefs consistently produce distinct acoustic spectra and generally higher sound levels compared to adjacent soft-bottom habitats, and that reef sound has daily, lunar and seasonal patterns. To investigate the habitat-related sound as a settlement cue, larval settlement responses to oyster reef and soft-bottom sound were tested for the Eastern oyster, Crassostrea virginica. Laboratory and field experiments suggest that sound has a significant

effect on oyster settlement rates: higher numbers of larvae settled in the presence of oyster reef sound than in soft-bottom sound or silent treatments. This study expands the scope of soundscapes as a cue for settling reef-builders, and also provides acoustic data needed to investigate the role of soundscapes in recruitment processes for estuarine species. In the context of marine conservation, the emerging evidence of the importance of soundscapes in recruitment processes suggests that protection or restoration of habitat-related soundscapes may also enhance larval replenishment of sound-receptive benthic species.

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PHYLOGENETIC CONSTRAINTS ON ELEMENTAL UPTAKE IN FLOUNDER OTOLITHS: AID TO INTERPRETING MIGRATION AND OTHER LIFE HISTORY EVENTS

Otoliths (earstones) take up many trace elements and most are assumed to be taken up in proportion to ambient environmental concentrations. However, it is known that some elements are endogenously regulated. In this regard, we have observed that magnesium is incorporated in proportion to growth rate in two of the right-eyed flounder species (winter flounder Pseudopleuronectes americanus and European flounder Platichthys flesus), but not so in a left-eyed species (southern flounder, Paralichthys lethostigma). Here we explore whether this phenomenon of growth regulated magnesium uptake is constrained to the Pleuronectidae (right eyed flounders) or is seen in other taxa as well. Growth-regulated Mg uptake can serve to help interpret other otolith chemical parameters, particularly in environments where growth is seasonally controlled. For example, the timing of migration (indexed by strontium and/or barium) or exposure to hypoxia events (indexed by manganese) can be assigned to temporal chronologies with the aid of Mg concentrations.

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FROM LAGOON MESOCOSMS TO CORAL REEF MESOCOSMS

Eutrophication is recognized as a problem stemming from pollution in coastal waters worldwide. There is particular interest in understanding how anthropogenic nutrient loadings regulate the structure and functioning of coastal ecosystems. The system-level mesocosm approach has been adopted in order to control the nutrient inputs to the system, to allow some replication within treatments and to observe the responses of organisms in the context of a relatively complex shallow water ecosystem. The lagoon mesocosms of GSO, URI were used as living models of shallow coastal lagoons along the southern shore of Rhode Island, USA to examine the effects of nitrogen (N) and phosphorus (P) enrichment on the development of epiphytes on eelgrass (Zostera marina L.). In contrast to the general paradigm of enrichment leading to greater epiphyte biomass, they found prolific growth of epiphytes in controls receiving very low rates of nutrient input and no increase in response to combined N and P enrichment. The coral reef mesocosms of NMMBA were used as living models of coral reefs in southern Taiwan to examine the effects of N and P enrichment on the scleractinian coral, Acropora muricata, the green alga, Codium edule, and a sea anemone, Mesactinia genesis. After 105 d of nutrient addition, A. muricata died after being totally overgrown by C. edule. M. genesis was observed to attack neighboring coral but move away from C. edule. Their results demonstrate that nutrient enrichment shifts the hierarchical dominance and inhibits corals' ability to compete with sea anemones and algae in southern Taiwan. It was evident that the responses of organisms to nutrient enrichment in these two system-level experiments were surprisingly complex. These results suggest that the mesocosm approach can provide a more realistic framework in which to document the impacts of changing environments on marine organisms.

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THE USE OF RIVER DIVERSIONS BY THE STATE OF LOUISIANA AND PREDICTED EFFECTS OF PROJECT OPERATIONS ON RECEIVING BASINS

Louisiana's severe coastal wetlands loss during the past century was in large part due to decoupling of the material flow of the Mississippi River and its distributaries from coastal wetlands following leveeing of the river for flood control and navigation. The State's Coastal Protection and Restoration Authority (CPRA) recognizes the fundamental need for river diversions within the State's project toolbox to re-establish the distribution of freshwater, nutrients and sediments to coastal wetlands. CPRA acknowledges, however, that diversions will change the existing physical and biological environments of both the rivers and receiving basins. The priority now is to understand and communicate the response of the receiving basins to diversion flows and the comparative future of those basins under scenarios of no further action. The many academic and agency studies conducted on the wetlands and estuaries receiving diversion flows help to better understand ecosystem and sociological responses to diversion operations and inform stakeholder discussions of trade-offs and management decision-making. Critically, there are caveats and limits to extrapolation in all studies that need to be explicitly defined to ensure that unjustifiable conclusions of diversion benefits or detriments are not made or perpetuated. CPRA has initiated an internal technical review of the available data on diversions as they relate to siting and operation of diversions; and responses within the receiving basins with regard to land-building processes; soil strength and plant productivity; estuarine and coastal water quality; and fisheries. This internal technical review will comprehensively summarize research and monitoring data in a manner that robustly considers study limitations, and will be complete by September 2013. This poster will present the resulting conclusions and recommendations for siting and operational considerations, as well as continuing research needs.

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BASIN-TO-BASIN AND NITROGEN-TO-PHOSPHORUS NUTRIENT EXCHANGES IN THE CHESAPEAKE TMDL

The Chesapeake Bay 2010 TMDL established ambitious nutrient reductions that are tracked biennially and are scheduled to be fully implemented by 2025. The TMDL allocation provides for equitable nutrient and sediment reductions among the 6 states in the watershed and for overall reductions to fully achieve the water quality criteria required for Chesapeake restoration. Within the established allocation framework, basin-to-basin and nitrogen-to-phosphorus nutrient exchanges allow for efficient and cost effective nutrient reductions. Basin-to-basin exchanges allow the movement of nitrogen and phosphorus load allocations between basins if an equivalent, or better, outcome for the water quality standards can be demonstrated as assessed by the TMDL models of the watershed (Watershed Model Phase 5.3.2) and estuary (Chesapeake Water Quality and Sediment Transport Model). Nitrogen-to-phosphorus exchanges allow exchanges between total nitrogen and total phosphorus nutrients within basins. In the Chesapeake TMDL, some states employed basin-to-basin exchanges, and most States employed nitrogen-to-phosphorus exchanges. The quantification, basis, and application of both nutrient exchanges will be described. Ultimately, achievement of the Chesapeake water quality standards can only be established with monitored data, so that implementation of basin-to-basin and nitrogen-to-phosphorus exchanges, along with trades among and between point and nonpoint sources, can be planned with the TMDL models, but can demonstrate meaningful achievement and success only by measurement and observation.

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THE NOAA MARINE DEBRIS MONITORING AND ASSESSMENT PROJECT

The NOAA Marine Debris Monitoring and Assessment Project (MD-MAP) includes a growing network of partners conducting shoreline monitoring surveys on a regular basis along the West Coast, Hawaii, and Alaska. Surveys follow standardized monitoring protocols developed by the NOAA Marine Debris Program and debris data and photos are uploaded to an online database to facilitate data sharing and analysis. One goal of the MD-MAP is to investigate potential shifts in debris types and abundance due to debris generated from the March 2011 earthquake and tsunami in Japan. This presentation will provide an overview of the MD-MAP efforts to date and discuss preliminary results and potential management applications.

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TIDAL INFLUENCES ON MICROBIAL COMMUNITIES RESPONSIBLE FOR SEDIMENTARY NITROGEN CYCLING IN THE CAPE FEAR RIVER ESTUARY, USA

Microbial communities involved in sedimentary nitrogen cycling are important regulators of nitrogen recycling and removal in estuaries and coasts. Tidal fluctuation can alter physiochemical features of a system causing changes in nitrogen metabolism as a result of shifts in microbial community structure. In order to understand tidal influences on estuarine nitrogen cycling, we examined potential activities and sediment communities during low and high tides in the tidal oligohaline reaches of Cape Fear River Estuary. Stable isotope incubations were conducted to measure potential rates of denitrification,

anammox, dissimilatory nitrate reduction to ammonia, and nitrification. Changes in microbial community structure in response to increased salinity will be examined using molecular techniques that target functional genes involved in nitrogen metabolism. Shifts in measured activities were observed with changes in salinity, elevated by 9.5 ppt at some sites. Nitrification activity tended to increase with increasing salinity and subsequent release of ammonium from sediments. Notable changes in anammox, denitrification and DNRA were observed, indicating a potential for shifts in the nitrogen metabolism of sediment communities with changing tides. Preliminary results from molecular analyses indicate shifts in denitrifier communities that coincide with tidal changes. Additional molecular investigations are underway to identify changes in functional gene expression that may occur as a result of tidal fluctuations.

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ANTHROPOGENIC INFLUENCE ON THE SEDIMENTARY DYNAMICS OF A SANDY SPIT BAR, PATOS LAGOON ESTUARY

Known to be transitional zones between the sea and the mainland, estuaries are featured due to their socio-economical and ecological importance, as well as their complexity and vulnerability to anthropogenic influence (including harbour activities). It is reasonable to consider that these influences produce changes in the dynamics of the region, resulting in modifications related to the biota, sediment transport, and flows between the estuary and the adjacent coastal zone. Alterations in the morphology of the Patos Lagoon Estuary due to the expansion of navigation activities in the area may reflect in weak features as sandy spits. Therefore, the objective of this work is to evaluate the effect of these alterations on a sandy spit (called Pontal Sul), based on numerical modelling (TELEMAC-3D) and remote sensing techniques (GeoEye images). Results were processed to evaluate areas of erosion and accretion and the coastline evolution of the sand spit. Both techniques indicate that the anthropogenic modification changed the rates of erosion and accretion in the sandy spit, and also highlight a longitudinal growing trend for the spit. The shoreline mean erosion displacement rate was 2.11 m/year, and the eroded area reached 64750 m^2. Furthermore, numerical modelling results indicated that these alterations in the sediment dynamics resulted from changes in the bottom velocity and shear stress.

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TEMPORAL CHANGES IN INTERACTIONS STRENGTHS WITHIN A KELP FOREST COMMUNITY: THE OTHER TROPHIC CASCADE

In kelp forests a multitude of trophic interactions have been described, trophic cascades identified, and in some cases "snap-shot" community-wide predator-prey interaction strengths quantified. However, our ability to understand the ecological consequences of localized kelp loss and environmental stochasticy on community dynamics is limited by our ability to isolate changes in the strength of habitat associations between kelp and their associated species from trophic interactions among both primary producers and higher trophic level species over time. Because the task of disentangling processes shaping kelp forest communities is difficult, few studies have addressed temporal variability in the strength of trophic linkages within kelp forests. Our goal was to elucidate how environmental conditions mediate proximate ecological responses and trophic interactions among species and communities that reside in rocky-reef kelp forests within the Lovers Point State Marine Reserve over time. For this study, we selected the invertebrate herbivorous mesograzer community which resides and feeds on the *Macrocystis pyrifera* canopy and, together with the zooplanktivorous fish which prey upon them, constitute a fish – grazer – kelp trophic cascade. To investigate how environmental and ecological factors mediate the strength of this cascade, we quantified the size and structure of the mesograzer community, the fish community that constitute their primary predators, alternate prey sources for those predators, the biomass of *Macrocystis pyrifera*, and grazing damage and obtained local environmental data from the Kelp Forest Array, a moored nearshore oceanographic sensor array, over a period of a year and a half.

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A 3,400-YEAR HISTORY OF ENVIRONMENTAL CHANGES AND EXTREME EVENTS FROM A HYPERSALINE LAKE ON THE SOUTHWESTERN COAST OF THE DOMINICAN REPUBLIC

We present a 3,400-year paleoenvironmental proxy record from Laguna Alejandro, a 25-hectare hypersaline lake on the southwestern coast of the Dominican Republic, with a surface elevation ~2 m above mean sea level. Three cores, extracted from opposite ends of the lake at water depths from 0.3 to 1.5 m, contain extensive peat deposits (60-175 cm thick) in the middle section, only to be replaced by microbial mats at ~20 cm from the core top. The transition to peat from the underlying clay, dated to ~1000 cal yr BP, is marked by a sudden drop in gastropod concentrations, suggesting an abrupt salinity change that caused massive mortality of gastropod populations in the lake. We attribute the submerged peat layers to large (>2 m) changes in lake surface elevation. The initiation of peat deposition was probably driven by an abrupt drop in lake level associated with the breaching of the beach barrier by a high-energy event. The subsequent drowning of the mangrove swamp that had developed on the exposed lakeshore is interpreted as resulting from the rebuilding of the beach barrier by a second extreme event. These extreme events may be caused by either tsunamis or intense hurricanes.

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SEASONAL QUASI-CLIMATOLOGICAL VARIATIONS OF PHYTOPLANKTON COMMUNITY STRUCTURE IN THE EAST CHINA SEA

Previous studies have reported spatio-temporal variations of phytoplankton community compositions in the East China Sea (ECS), however the sampling resolutions of these studies are still insufficient for a comprehensive understanding. In the present study, phytoplankton community structure was investigated in the ESC during 11 cruises since 2006 (sample size=2040). Diagnostic pigments concentration was determined by HPLC-CHEMTAX analysis to obtain the chlorophyll *a* (Chl *a*) biomass of nine phytoplankton groups. In addition, the dominant species were confirmed by a microscope. Generally, diatoms was the dominated group in the ECS, while dinoflagellates, cryptophytes, chrysophytes, cyanobacteria, and prochlorophytes can be considered as important groups in different spatio-temporal scales. Consistent with previous studies concentrations of dinoflagellates were quite high in the estuary and coastal area during spring. Further, our study revealed it was significantly lower when salinity was higher than 33 or temperature was higher than 28 ^{o}C. The contributions of dinoflagellates to the total Chl *a* biomass seemed greater than those of diatoms in the estuary and coastal area during spring. In the competition of diatoms and dinoflagellates temperature, nutrients ratios and composition seemed to play very important roles. In addition, cryptophytes were high in waters with temperature below 20 ^{o}C. During cold seasons, cyanobacteria distributed in off-shelf waters with temperature higher than 20 ^{o}C. However, the highest concentration of all samples was found in the estuary during summer. Prochlorophytes mainly distributed in the oligotrophic Kuroshio waters. In summary, different seasonal patterns of Chl *a* biomass and phytoplankton community structure were observed between estuary, coast, shelf and off-shelf, suggesting different mechanisms in these areas.

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EFFECTS OF PHYSICAL FORCING STRENGTH ON DIAGENESIS OF SEDIMENTARY ORGANIC MATTER IN SALT MARSHES ALONG THE GULF OF MEXICO COASTS

Physical forcing, including tides, currents and waves, may play an essential role in breaking down large plant detritus to smaller pieces especially in dynamic environments such as salt marshes and continental shelves. For example, high energy may remove plant detritus via winnowing and sorting in river-coastal margins. Physical energy differences likely also explain the distribution and diagenesis of fine-grained minerals in the size separates among different wetland sediments. In this study, we compared sedimentary organic matter (SOM) including bulk organic carbon and specific compounds, grain size distribution, and specific mineral surface areas of wetland sediments from south Texas and Louisiana coasts. The specific compounds include total hydrolyzable amino acids (THAAs), n-alkanes, and polycyclic aromatic hydrocarbons. Based on compositions of THAAs and n-alkanes, our results showed that SOM became more degraded towards finer size fractions, from >300 μm, 300-125 μm, 125-63 μm, 63-32 μm to <32 μm, a typical degradation pattern observed for sediments from coastal and lacustrine environments. However, the contents of organic carbon, THAAs and n-alkanes were higher in sandy fractions than in silt and clay fractions in wetlands with weak physical forcing strength, while the opposite was observed in wetlands with strong physical forcing strength. Overall, physical forcing may control the diagenesis of wetland SOM, and may be an important mechanism in processing and transport of OM from vascular plants and other organic sources in estuaries and bays before being exported to coastal oceans.

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LONG-TERM EFFECTS OF CLIMATE CHANGES ON TROPHIC ORGANIZATION OF COASTAL SYSTEMS

Since 1955, the rivers and coastal areas along the NE Gulf of Mexico have been subject to long-term climate changes that include increased water temperature, increasing frequency and duration of droughts, and enhanced rain events. From 1955-2012, there were five major droughts where intervals between droughts were reduced by around half with each succeeding event. Long-term (43 years) studies of the Apalachee, Apalachicola and Perdido systems in the N. E. Gulf of Mexico indicated reduced productivity and altered trophic organization that were linked, in part, to climatological trends. The specific impacts of climate change varied in the different study areas. The high salinity Apalachee Bay, without the influence of major river flows, experienced a complex series of alterations of the dominant grass bed communities. Reduced flows of the Apalachicola River resulted in the loss of the major oyster, blue crab and white shrimp populations in Apalachicola Bay leading to a collapse of the regional fishery production. In the Perdido system, the combination of dredging, toxic plankton blooms and reduced flows of the Perdido River resulted in the almost complete loss of fish and invertebrate productivity. In all three systems, the trophic organization was altered in complex ways. Although there is no way to predict future climate conditions, the increasing severity of the drought and rain event trends with time in the NE Gulf coast region has already resulted in serious losses of formerly valuable coastal resources. This does not bode well for the future of what was once one of the most productive coastal areas in the country. These losses should be viewed within the current state of ignorance of and indifference to issues involved with regard to climate change. The lack of meaningful long-term research in most coastal systems aggravates a growing problem.

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DESIGN FOR FLOODING: TOWARDS SOCIAL-ECOLOGICAL SYSTEMS

We are no longer confronted with an indifferent kind of nature but with an environment characterized by a profound blurring of social and biophysical processes. Within this context, this paper explores the potential of spillways as multi-functional flood control systems that enable positive relations between social and ecological processes. Spillways not only act as nutrient and sediment sinks—improving water quality and providing habitats for a variety of fish and wildlife species—they also provide multiple opportunities for resource management and recreation. The Bonnet Carré Spillway, located 15 miles upstream from New Orleans along the Mississippi River, serves as a case study to highlight how the working and reworking of geography through designed flooding has created a dynamic equilibrium between social and ecological system. With the periodic flooding of the 3085 hectare spillway landscape—nearly 10x the size of Ne York's Central Park—come large volumes of silt deposits. In order to maintain required flow rates and water storage capacity of the spillway, much of this sediment is excavated and sold to local construction projects. As a result, the configuration of the spillway, its relative elevation, vegetation types and densities, and surface conditions are constantly in flux. Moreover, these dynamic conditions have not only provided important habitats for wildlife, they have also enabled a wide range of human activities, including fishing, boating, hunting, camping, as well as ATV and 4x4 off-road racing. The Bonnet Carré Spillway provides a promising approach for reconsidering current flood control practices. A model that moves towards climate change adaptation strategies based on principles of flux rather than fixity. Flooding is no longer seen as a threat but rather as an opportunity for to create resilient coastal and estuary landscapes organized around sustainable interactions among social and environmental systems across a range of scales.

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MANGROVES IN THE EASTERN TROPICAL PACIFIC: THE FORGOTTEN INTERFACE BETWEEN LAND AND OCEAN

Despite their increasing inclusion in protected areas, the current rate of mangrove loss has received scant public attention or political recognition, especially in developing countries of Latin America where mangroves of the Pacific coast are extensive and abundant in highly complex estuarine systems among river deltas. Here we review the existing information on the coverage of mangrove forests in the Eastern Tropical Pacific region through time and analyse the extent of mangrove protection along with the effectiveness of the policies in place. The results show marked mangrove loss trends throughout the region dating back to the colonization period. The remaining mangrove system of the Eastern Tropical Pacific is often inadequately protected by ineffective management that is poorly enforced. Less scientific research has been performed on mangroves compared to coral reefs and rainforest, and the ecological and social value of this ecosystem tends to be under-rated in the region, overlooking the role of mangroves as important providers of ecosystem services. We suggest the implementation of a new conservation agenda thrusting mangrove protection into the limelight, emphasizing the need for integrated coastal management actions to maximize protection benefits in economic activities such as fishing. As mangrove forest loss has proven to have negative implications on the livelihoods of the most vulnerable sectors of societies, conservation efforts need to be supported with effective governance systems, restoration initiatives and education programmes.

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SPACE RACE: GEOGRAPHIC AND TEMPERATURE-INDUCED CHANGES IN FOULING COMMUNITIES

Marine epibenthic (fouling) communities are useful systems for studying community composition because of the importance of growth rate, overgrowth competition and space limitation. Fouling systems have been examined in order to assess shifting range limits, spread of invasive species, and shifts in species assemblages with climate change. Even though data on invasions and community shifts show correlations with climate change, causation cannot be established without studies of thermal responses and other underlying mechanisms. This study experimentally assessed growth rates of several tunicates and bryozoans in 8 regions along the east and west coasts of the United States, from southern California to Alaska and Florida to Maine. Several encrusting species showed significant changes in growth rate as well as large variability between regions in response to increased temperature. Photo surveys of floating docks were also conducted at 20 harbors in each region in order to compare communities and overgrowth competition. On the west coast of the US, competition between encrusting ascidians and bryozoans was more intense at southern than northern sites, and invasive species tended to be dominant competitors. Results for the east coast did not show the same latitudinal patterns in competition but did display similar dominance by invasive species. Photo surveys also enabled the characterization of relative abundance of several fouling species throughout a large portion of their geographic ranges. The ultimate goal of this project is to predict the impact that invasive species will have on fouling communities after the invasives are introduced and become established in a new region.

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LITTLE LAKE WORTH FLORIDA, A 'BORROW-PIT' STYLE COASTAL LAGOON: USE OF PIGMENTS AND WATER QUALITY TO DETECT ANTHROPOGENIC PERTURBATIONS

As part of the senior author's studies on photosynthetic microorganisms (phytoplankton, bacteria, etc.) and their relation to nutrient pollution (eutrophication) in southern Florida fresh, brackish and marine waters, a random sampling of Little Lake Worth, Florida was conducted in 2004 and we found that the bottom waters were strongly anoxic with a large growth of brown S-bacteria. Additional study was then undertaken in 2009. Monthly water samples collected from a deep (>9m) basin (80o03.50'N x 26o51.00'W) at 0.5-1.0 m intervals were filtered, extracted and pigments analyzed by HPLC-UV/Vis spectroscopy. Sediments were collected using a Wildco corer modified to be a free-fall gravity corer. Sediment samples (frozen) were sectioned in 10 cm intervals. Filtered seston or sediments were extracted and chromatographically analyzed for photosynthetic pigments. A HACH Hydrolab multiparameter sonde was used to measure temperature, salinity, pH, nitrate and dissolved oxygen. Pigment-based chemotaxonomic analyses of phytoplankton populations revealed a biomass, using taxon-specific chlorophyll-a as a proxy, order of: diatoms >> chlorophytes > chlorophytes ~ dinoflagellates > cryptophytes in the upper aerated water column through most of the year. In June through August a strong oxy-/chemocline formed with large amounts of brown S-bacteria, as indicated by large amounts of bacteriochlorophyll-e below about 5m. Salinity, nitrate and T indicated fresh water entering from the bottom. We conclude that leaching from on-site disposal systems (OSDSs), namely septic tanks, plus inputs from heavily fertilized lawns / golf greens surrounding Little Lake Worth, provides enormous amounts of organic matter and plant nutrients (N,P) to the basin. The depth and lack of flushing provide the geomorphologic stage for the development of strong seasonal anoxia, supporting large amounts of the brown S-bacterium, Chlorobium phaeobacteroides, in the sulfide-rich hypolimnion.

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IDENTIFYING CRITICAL HABITATS FOR HORSESHOE CRABS: THE IMPORTANCE OF UNDERSTANDING CHRONOLOGY IN PRIORITIZING CONSERVATION EFFORTS

A limited and highly mobile reservoir of intertidal sand on the shores of Delaware Bay creates a dynamic challenge to spawning horseshoe crabs (Limulus polyphemus). Natural processes, particularly long-term global ocean rise and episodic intense storms, may result in the movement of sand from erosional to depositional sites. We have previously found that optimal spawning beaches for horseshoe crabs are characterized locally by deep (> 20 cm), well-oxygenated sands, with grain-size distribution conducive to successful

embryonic development. In Delaware Bay, thousands of years of gradual sea level rise have repositioned optimal beaches shoreward, gradually covering existing salt marsh. During storms, sand may be transported further onto the marsh from the beach, creating a reservoir of sand that contributes to future spawning habitats. Existing beach may be degraded, resulting in a thin veneer of sand over decaying, anaerobic marsh sediments which horseshoe crabs actively avoid. When beaches are armored to protect the shoreline, the natural progression of the beach landward cannot occur; consequently, the sand and spawning habitat are ultimately lost. Spawning horseshoe crabs may then be forced to seek marginal habitats, or utilize limited optimal sites, for reproductive purposes. Because of the important relationship of horseshoe crab eggs to migratory shorebirds, efforts are being made to re-nourish and restore previously optimal beaches. Even when efforts are made to include proper grain size, slope, etc., beach nourishment may have only short-term success: the physical forces related to beach erosion (ocean rise, currents, storms, etc.) are still intact. The enormous and recurring economic costs of beach replenishment suggests that a strategy of organized retreat coupled with preservation of marginal spawning habitats may be the most viable long-term response to beach migration and erosion.

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PHOSPHORUS ENRICHMENT AND CARBON SEQUESTRATION IN MANGROVES

Phosphorus is a key element required for growth of plants and limits primary production in some mangrove forests, but it could also accelerate metabolic activity of soil microbial communities and thereby enhance decomposition of soil organic matter. Coastal wetlands, including mangrove forests, are important global sinks for carbon, but they are exposed to anthropogenic nutrient enrichment which may reduce their efficiency as carbon sinks. Using gradients in nutrient availability over landscapes, long term fertilization experiments and short term experiments we assessed soil carbon burial, soil carbon density and carbon dioxide efflux from soils enriched with nutrients. Evidence across a range of sites indicates that while enhancement in primary production can occur with phosphorus additions, enrichment with phosphorus does not increase the efficiency of soil carbon sequestration or the density of soil organic matter but increases efflux of carbon dioxide from soils.

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THE HORIZONTAL LEVEE: NATURE'S LOW COST DEFENSE AGAINST SEA LEVEL RISE

An ambitious region-wide plan is underway in San Francisco Bay to restore over 100,000 acres of coastal marshes. However, scientists now recognize that many of the Bay's restored wetlands will be at risk of being drowned by rising sea level. Storm surges occurring atop higher sea level already are causing increased flooding within the San Francisco Bay shoreline zone, as well as within low-lying developed areas near the bay. An aging network of coastal levees is increasingly overburdened and will prove thoroughly inadequate as sea level continues to rise during the coming decades. Scientists have known for decades that coastal wetlands can help protect oceanfront cities from the powerful destructive forces of storms. This study examines the costs and benefits of employing marsh restoration as an adaptation strategy to rising sea levels in San Francisco Bay. It presents the Horizontal Levee as a new concept in coastal flood protection that uses an innovative design to mimic the configuration of the undeveloped shoreline. The Horizontal Levee uses the natural flood protection benefits of coastal tidal marshes to reduce the destructive forces of storms. It can be applied during the current era of sea level rise to augment the protective benefits of engineered levees and reduce construction and maintenance requirements. This preliminary study suggests that this new approach can be an effective interim strategy to reduce storm damage caused by sea level rise and that the cost of implementation can be significantly lower than that of traditional levees.

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HIERARCHICAL EVALUATION OF THE IMPACTS OF COASTAL URBANIZATION ON SALT MARSH NEKTON ASSEMBLAGES AND FOOD WEB STRUCTURE

Salt marsh habitats are a defining feature of temperate coastal landscapes and are among the most anthropogenically altered ecosystems in the world. Amongst these alterations, urbanization (i.e., the serial replacement of natural salt marsh habitats with man made structures) has the potential to disrupt the delivery of numerous ecosystem services that relate to the maintenance of economically and ecologically important nekton (i.e., fish and decapod crustaceans) assemblages. In this paper, we use abundance data to show that salt marsh nekton assemblages are compositionally altered in highly urbanized coastal landscapes. Further, we use a suite of quantitative stable isotope metrics to show that food web structure (e.g., increased food chain length and homogenous resource use) is altered in highly urbanized coastal landscapes. However, stomach content analyses suggest that increased food chain length could be interpreted as a nutritional stress response to altered foraging patterns. Overall, these results indicate that coastal urbanization negatively impacts salt marsh nekton assemblages in a number of ways and ultimately hinders support of valuable fisheries.

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SIMULATING LIGHT AVAILABILITY FOR SEAGRASS HABITAT IN CALOOSAHATCHEE RIVER AND ESTUARY WITH AN ENHANCED LIGHT ATTENUATION MODEL

The Caloosahatchee River and Basin, in southwest Florida, stretch 70 miles westward from the western edge of Lake Okeechobee to San Carlos Bay. The basin drains a total of 1,408 square miles of agriculture, forest, wetland and urban areas. The river has been modified and channeled to accommodate navigation, flood control, and land reclamation needs by several drainage districts since early last century. A series of locks and spillways control the river from Lake Okeechobee to San Carlos Bay. Because of that, the amount and timing of freshwater flows into the lower Caloosahatchee/San Carlos Bay Estuary have been significantly altered, which in turn impacts water quality in the river and estuary. Nutrient loading from ever-growing urban area and various agricultural practices contributes greatly to the degraded water quality in the system. A three-dimensional hydrodynamic and water quality EFDC model was developed, along with a watershed model of the basin, for the Caloosahatchee River and Estuary in support of dissolved oxygen and Chlorophyll-a TMDLs development in 2008. A recent model improvement included model grid refinement and extension and employed an enhanced light attenuation model to accurately and dynamically simulate light availability for seagrass habitat in Caloosahatchee River and Estuary. The simulated Secchi depth and/or light extinction coefficient compared well with the observed. The enhanced light attenuation model which was coded in EFDC is able to temporally and spatially compute light extinction due to 1) pure water background light extinction; 2) inorganic total suspended solids (TSS) light extinction; 3) chlorophyll light extinction; 4) light extinction due to POC; and 4) light extinction due to CDOM.

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GENERAL, IDEALIZED MODELS FOR INTEGRATING EFFECTS OF BIVALVE GRAZING WITH PHYSICAL HABITAT ATTRIBUTES TO BETTER UNDERSTAND PHYTOPLANKTON DYNAMICS AND INFORM ECOSYSTEM MANAGEMENT

As described by Kemp and Boynton (2012), one approach used in synthetic ecological research is "general systems simulation modeling." In this mode of synthetic study, mechanistic simulation models may be implemented to test general hypotheses concerning linkage and integration of multiple physical and/or ecological processes. These models may be spatially aggregated idealizations of ecosystems that provide neither definitive, all-inclusive depictions of estuarine processes nor quantitatively faithful simulations of specific individual systems. However, they may represent powerful tools for assessing linkages between collections of processes operating across a broad number of systems. Moreover, because of their simplicity, these models may be ideal for isolating specific sets of processes, dissecting their interactions, and clearly communicating their effects. We have developed two idealized, spatially aggregated mathematical models to isolate, examine, and communicate how controllable physical habitat attributes (water depth, hydraulic transport time) interact with a less controllable ecosystem stressor (exotic bivalve grazing) to influence phytoplankton biomass and productivity. We use these mathematical models to test two common, intuitive conceptual models cast as the following hypotheses: 1) shallower

habitats have greater phytoplankton biomass and productivity than deeper habitats, and 2) hydrodynamically "slower" habitats have greater phytoplankton biomass and productivity than "faster" habitats. The mathematical models reveal that both hypotheses (which are influencing multi-billion dollar restoration plans) should be abandoned when bivalve grazing is strong. Field measurements have corroborated the model findings. The origin, development, and management implications of this research will be discussed.

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COMPLEXITIES OF THE BENTHOS: SPATIOTEMPORAL VARIABILITY OF BENTHIC MICROALGAL COMMUNITIES IN GALVESTON BAY, TX AND THEIR RELATIONSHIPS WITH THE ENVIRONMENT

Galveston Bay is a shallow, wind driven estuary, and one of the seven major estuaries on the Texas coast. Galveston Bay receives inputs of freshwater and nutrients (sewage and agriculture derived) from Houston and the Dallas-Fort Worth areas via the Trinity and San Jacinto Rivers. Benthic microalgae (BMA) have been suggested to play an important role in the food web dynamics and biogeochemical cycling of shallow estuaries such as Galveston Bay. Environmental factors including salinity, temperature, pH, nutrient concentration, water clarity, and sediment grain size are potentially involved in structuring the communities of BMA in Galveston Bay. This study reports on the dynamics of these biotic and abiotic parameters, and their interrelationships with the distribution, abundance, and composition of BMA communities. To investigate these connections, 4 sites were sampled over a time series of 3 years (2010 to 2012) in March and July, representing historically high and low freshwater inflows. The cross-system sampling locations include the Trinity River Basin, the San Jacinto River Basin, a central bay station, and a station at the mouth of the Bay meeting the Gulf of Mexico, representing the gradient of freshwater inputs into the Bay to the Gulf. Five cores were collected at each station, sealed, and incubated in the dark for 4 hours in aquaria with recirculating water at in situ temperature. Pre- and post-incubation subsamples assayed dissolved oxygen and total and dissolved nutrient fluxes, water column phytoplankton, sediment grain size, and BMA. High Performance Liquid Chromatography was utilized to examine the microalgal community composition. Because BMA communities are closely biochemically linked to the water column phytoplankton, examining and understanding these biogeochemical relationships will aid in the development of food webs and nutrient budgets for this and other similar ecosystems.

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SHELLFISH AND WATER QUALITY: SEARCHING FOR POLICY OPTIONS IN CHESAPEAKE BAY CLEANUP

Most of the tidal waters of Chesapeake Bay are listed as impaired by the U.S. Environmental Protection Agency, primarily as a result of excessive loading of nitrogen, phosphorus and sediments from the watershed. Current regulations establish Total Maximum Daily Loads (TMDL's) on a tributary basis for reducing these loadings, with nitrogen accounting for the largest share of required reductions. State and local governments are increasingly looking for policy options for including filtration effects of bivalves as a means of meeting their load reduction requirements for nitrogen, though few policymakers comprehend the importance of nitrogen dynamics in crafting such policy. Using measured rates of denitrification associated with oyster reefs and oyster aquaculture from various studies within the region and published values for tissue nitrogen content, we consider the potential roles of oyster aquaculture and oyster restoration in nitrogen removal in relation to TMDL requirements for several tributaries within the Chesapeake Bay. The results indicate that (1) high variability in measured denitrification rates currently limits the development coherent policy, (2) the potential for oysters to have a substantive impact on meeting nutrient reduction targets varies widely with tributary, primarily as a function of the magnitude of the reduction targets and (3) there is a need for a better understanding of how environmental factors affect nitrogen dynamics associated with high densities of oysters on reefs and in aquaculture.

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LESSONS FROM CHESAPEAKE BAY RESTORATION EFFORTS: UNDERSTANDING THE ROLE OF NUTRIENT REDUCTION ACTIVITIES IN IMPROVING WATER QUALITY

The degradation of water quality and habitat conditions within the Chesapeake Bay Watershed led to the development of the Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment (TMDL). TMDL requirements have reinforced the need to understand the effectiveness of best management practices (BMPs) to ensure compliance with local and regional water quality load allocations and targets. Within the Watershed scientific and management community, BMP evaluation has largely relied on estimates from ecosystem models. Given the performance driven structure of the TMDL, the Tidal Monitoring and Analysis Workgroup and the Nontidal Water Quality Workgroup of the Chesapeake Bay Program Partnership took on the task of connecting BMP operations with real-world water quality monitoring data. We conducted a literature review of over 40 case studies to synthesize the state of knowledge of BMP effectiveness; three major themes emerged: 1) proven practices; 2) challenges; and 3) the need for targeted practices. Data revealed that: 1) upgrades to wastewater treatment plants, decreases in atmospheric nitrogen deposition, and reductions in agricultural nutrient inputs directly improve water quality; and 2) delays between BMP implementation and observable water quality improvements may impede progress. Additional factors such as population growth and increased stormwater runoff may counteract the impacts of effective BMPs. Identifying all nutrient sources and targeting BMPs accordingly, as well as improving stormwater management to accommodate population growth are necessary to improve water quality and habitat conditions. We also recognized that: 1) long-term quantitative data collection is essential to monitor the effectiveness of BMP implementation; 2) evaluating BMPs in a variety of settings will help identify those practices most effective based on location and conditions; and 3) BMP evaluations should inform future management decisions.

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EXPLORING PERCEPTIONS AND EXPERIENCES OF THE U.S. WEST COAST SHELLFISH INDUSTRY DEALING WITH OCEAN ACIDIFICATION

Nearshore and estuarine environments along the U.S West Coast have been identified as "hotspots" experiencing accelerated impacts from ocean acidification (OA) due to reinforced effects of local drivers. Water with poor carbonate chemistry has been correlated with production losses of Pacific oyster *(Crassostrea gigas)* larvae at hatcheries in the Pacific Northwest. Limited and unreliable supply of larval seed from hatcheries has implications for the economic well-being of commercial growers. However, little is known about how the shellfish industry perceives OA related obstacles and envisions adaptation. To tackle this information deficit, we conducted an online survey of shellfish hatcheries and growers across Washington, Oregon, and California to better understand stakeholder perspectives and experiences. The 86 stakeholders who participated in the 44-question survey represented a 45.5% response rate and included oyster, clam, mussel, geoduck, and abalone industries. Participants reported their understanding of OA drivers, experience from OA impacts, level of concern, and adaptation strategies. Respondents indicated which environmental measurements and information sources inform their business practices, the usefulness of University-based research, and their willingness to share monitoring data. Survey findings show that 74.6% of participants think University-based research is *usually* or *extremely useful*, and 68.7% reported they are *very willing* to share data with scientist to help refine research models. Participants identified the shellfish industry as the entity with highest priority for addressing OA, followed closely by science. 52.0% of respondents indicated they have personally experienced negative impacts from OA, and 63.6% feel the shellfish industry is *definitely* or *somewhat able* to adapt. This research has implications for advancing mutually beneficial relationships between science and industry when addressing the multifaceted problem of OA.

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ESTUARINE AND COASTAL MECHANICAL ENERGY

A method is presented for calculating a closed mechanical energy balance using history, average, and diagnostic files from a ROMS simulation. This gives the tidally averaged, vertically integrated flux divergence terms in the potential and kinetic energy budgets. Energy reservoir terms that depend on these fluxes, such as available potential energy,

are also calculated. The methods are applied to a realistic simulation of the Salish Sea and NE Pacific coastal waters, highlighting the energetic signatures of wind-driven upwelling, coastal trapped waves, canyon flows, and the estuarine exchange flow.

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NEW HAVEN'S WEST RIVER: THREE RESTORATION PROJECTS ON A UNIQUE URBAN WATERWAY MAKE ONE CITY MORE RESILIENT

The West River in New Haven is only 18 miles long with a watershed of 36 square miles. In that short distance, the river flows from its headwaters in forested central Connecticut through dams impounding its flow for drinking water use, protected forest in an affluent suburban community, well-loved and highly used city parks, out restrictive tide gates, and into Long Island Sound. On this river, Save the Sound and our partners had the unique opportunity to reestablish tidal flow to over 80 acres of tidal freshwater marsh and restore diadromous fish passage to almost the entire historic length of the main stem river, arguably the largest urban marsh restoration project in the northeast United States. After more than 20 years of planning, not only was the project team able to reestablish tidal flow to the river, we applied the same coalition building techniques and used local recognition gained from the original project to reestablish a native freshwater and brackish tidal marsh in a park designed by Frederick Law Olmstead; and to remove a derelict dam even further upstream. We will share innovative solutions and community involvement techniques that were necessary in this heavily populated urban watershed, and valuable to any watershed-scale, holistic approach to restoration. Our restoration effort spanned the time when two very different storms hit the northeast: Sandy and Irene. We will look at how the West River and greater New Haven differently during each of these storms and how estuarine restoration can make our coastal cities more resilient.

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A COMPARISON OF TWO DIFFERENT METHODS FOR ESTIMATING NATURAL MORTALITY RATES OF JUVENILE WHITE SHRIMP *LITOPENAEUS SETIFERUS*

Natural mortality is an important, yet difficult to estimate, parameter in models of fishery population dynamics. This parameter is essential in stock assessment models, and a comparison of mortality rates can be used to identify essential habitat and nursery areas for fishery species. Most previous estimates of natural mortality for juvenile penaeid shrimps were based on length-frequency data, which may not provide accurate estimates in the presence of size-dependent processes (e.g., predation). The purpose of our study was to compare two methods for estimating natural mortality rates of juvenile white shrimp *Litopenaeus setiferus*. We collected shrimp in a salt marsh of the Sabine Lake estuary during July and August 2012 with a drop sampler and used shrimp length-frequency data from these samples to estimate mortality. For comparison, we conducted mark-recapture experiments concurrently in two small tidal ponds within the study area. For the mark-recapture experiments, the model that best represented the data for each pond included fishing mortality rates that varied over time and a constant natural mortality rate. Natural mortality estimates (95% CI) were 0.118 day^{-1} (0.045 - 0.191) and 0.010 day^{-1} (0.000 - 0.072). The 2 estimates of natural mortality (95% CI) we obtained from the length-frequency data were 0.053 day^{-1} (0.040 - 0.067) and 0.027 day^{-1} (0.000 - 0.054). These estimates are within the range of values of the few previously reported mortality rates for this species. We did not find any strong evidence for differences in the natural mortality estimates between the two approaches.

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HUMAN AND CLIMATE IMPACTS ON COASTAL 'BLUE CARBON' SINKS

How has past human activity and climate change influenced the carbon sequestration capacity of 'blue carbon' habitats? To address this question, we reconstructed the sedimentary records of cores taken from estuaries dominated by seagrasses, salt marshes, and mangroves on the east coast of Australia to look for major changes in sedimentary carbon during the past ~9,000 years – a period that covers industrialization and natural warming events. We used a range of paleoreconstruction proxies (incl. radiocarbon chronologies, stable isotopes, foraminiferal assemblages) to develop detailed chronologies and infer external forcings that influence carbon sequestration. The first significant change we identified was ~1700 – 2700 years ago, whereby sedimentary carbon stock was ~8–18 times higher than background levels. This period coincided with maximum El Niño-Southern Oscillation (ENSO) variability. Our data suggests that strengthening of the ENSO signal increased the supply of terrestrial carbon into estuaries (due to drought/fire/flood cycles), which, because of its high burial efficiency, resulted in significant increases in carbon stocks. The second major change occurred shortly after European settlement, whereby industrialization and concomitant eutrophication led to a ~100-fold weakening of the carbon sink capacity of seagrasses-dominated estuaries. This change occurred due to an increase in the relative contribution of microalgae to detritus, and a corresponding decrease in the contribution of seagrass to detritus. Overall, this research suggests that ENSO-like climate changes have the potential to trigger enhanced carbon burial in seagrass-dominated estuaries, whereas eutrophication weakens to the carbon sequestration capacity of seagrass ecosystems. More information (incl. videos, photos, and pdf links to papers) at www.petermacreadie.com

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INTERACTIONS BETWEEN WAVES, SEDIMENT, AND TURBULENCE ON A SHALLOW ESTUARINE MUDFLAT

Observations of tides, turbulence, and wind-waves on a shallow mudflat in northern San Francisco Bay illustrate the mechanisms that control shear stresses on the bed and drive sediment resuspension in this estuarine environment. Measurements spanning the transition from intertidal to subtidal mudflat were collected in the spring of 2011 in San Pablo Bay. During wind events, wave-driven bed shear stresses elevated concentrations of suspended sediment near the bed such that stable density stratification was induced. Density variations were attributed to suspended sediment concentration since salinity and temperature were largely uniform throughout the water column. Direct measurements of the buoyancy flux were provided by each of five ADVs on three instrument frames and demonstrated the dynamical relevance of the stratification to the turbulence field with values 1-10% of shear production. Contrary to expectations, increased near-bed turbulent shear stresses were observed during these stratification events, and shear production was heightened in particular. The observed increases in velocity shear in the lowest 30 cm of the water column during wind events were attributed to return flows generated by set-up at the coast from wind shear and Stokes transport, which enhanced the offshore flows on ebb tides. The increased shear production resulting from event-scale wave dynamics augmented bed shear stresses, reinforcing the impact of waves on sediment resuspension. The data illustrate that there were layered feedbacks between wind waves, sediment resuspension, and turbulent motions, and that wave events lead to stable stratification and a very energetic turbulence field in which the buoyancy flux became an important factor in the balance of turbulent kinetic energy.

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EXPLORING LINKAGES AMONG WATERSHED-ESTUARY PROCESSES IN THE SOUTHERN EVERGLADES, FLORIDA BAY USING MODEL SYNTHESIS

Many of the stresses impacting watersheds are manifest downstream in estuarine waters. The Everglades-Florida Bay, FL ecosystem is a complex juxtaposition of natural environments and human development characterized by altered hydrology, changing land use patterns, nutrient enrichment and consumptive water use impacting coastal Florida waters. Florida Bay is managed by regulating hydrology and nutrient inputs far upstream via passive and active control structures. Changes to the hydrological management infrastructure and to operations are being assessed for downstream ecological consequences. A synthesis of research and modeling is used to constrain and create restoration alternatives and predict management outcomes. The approach, including an ecological monitoring network, targeted experiments and modeling, is used to simulate the human-natural system, develop testable hypotheses, and to test alternative management strategies. A series of model parameterizations has been developed using a soft-linkage of SFWMD's Regional Simulation Model (RSM) hydrological model and the Seagrass Ecosystem Assessment and Community Organization Model (SEACOM) ecosystem model to predict trajectories for seagrass community composition, distribution, productivity and life history under local management scenarios and global changes such as sea level rise. The modeling synthesis is also used to explore the dynamics between benthic versus water column production. The models have elucidated the existence of "tipping points" where the Florida Bay ecosystem can switch from an oligotrophic, clear water system dominated by seagrass to one dominated by phytoplankton, turbid water and a diminished benthic component. Numerous pathways to this system switch are identified, including impairment of algal grazers, increase in salinity, turbidity and basin residence time, change in N species, inorganic:organic ratio or stoichiometry to lower N:P, and elevated rates of autochthonous remineralization.

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A PATH TO MORE ROBUST AND ACCESSIBLE PREDICTIVE FRAMEWORKS TO SUPPORT COASTAL ECOSYSTEM MANAGEMENT OF NUTRIENTS

One of the most damaging impacts of excessive nutrients on estuarine and coastal systems is hypoxia. Mathematical models have been used to guide nutrient management goals and actions as recognition of the impacts and solutions has grown along with the sophistication and confidence of model predictions for management decisions. The demand for management-relevant information has led to a proliferation of approaches used by practitioners in consulting firms, academia and government agencies. While multiple, or ensemble, approaches are often desirable to increase confidence in forecast outcomes, the current situation of largely ad hoc model development and application is costly and perhaps not the most efficient and effective use of capabilities. In existing and new areas affected by hypoxia, there are increasing demands for actionable information on more refined questions such as whether precise targeting of reductions in the forms of N and P, or timing and location of delivery of loads to coastal waters, is important to consider in management strategies. Models to guide management of hypoxia increasingly include those used to evaluate impacts to habitat and living resources; these are particularly needed to support informed goal-setting and allow hypoxia to be evaluated along with other stressors in an ecosystem framework. Within this context of growing management information needs and evolving modeling capabilities, NOAA has embarked on an effort to determine if there are paths, or roadmaps, to new operational frameworks which could deliver reliable predictive information with greater efficiency and broader availability nationally. This presentation will explore the multifaceted approaches being pursued by partners within and outside of NOAA including model testbeds, further refinement of user needs, integration of water quality and ecosystem models, linkages with watershed models, and new approaches for observations and associated data management and assimilation.

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EFFECT OF SALINITY ON GROWTH OF JUVENILE YARRA PYGMY PERCH (*NANNOPERCA OBSCURA*: PERCICHTHYIDAE)

The threatened Yarra pygmy perch (*Nannoperca obscura*, Klunzinger 1872) is endemic to the south-eastern coast of Australia, where its native river systems have been heavily modified since European settlement. The purpose of this study was to explore the relationship between the growth rates of juvenile *N. obscura* and salinity. Growth trials were conducted using five salinity treatments (0.3-10.0 ppt) representing perceived and potential salinity values within *N. obscura*'s environment. After eight weeks of exposure, growth was recorded as weight (g) and standard length (mm). Growth was optimal when *N. obscura* was exposed to moderate salinity concentrations (3.0-8.5 ppt), therefore identifying the ideal salinity range for *N. obscura*. During this study, juveniles from two brood-groups were trialed simultaneously in an attempt to quantify intraspecific variation in phenotypic response to salinity, however no significant differences in the genetic composition of the two groups was detected. This indicates a limited genetic variance which may restrict the adaptability of *N. obscura* and impair its ability to survive continuing salinity modifications occurring in its native habitat.

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ONSET OF UNPRECEDENTED TOXIN-PRODUCING CYANOBACTERIAL BLOOMS IN THE CAPE FEAR RIVER SYSTEM, NORTH CAROLINA

The Cape Fear River is heavily used as a source of drinking water and industrial process water. It is a nutrient-enriched system from point-sources and CAFO runoff, yet algal blooms had historically not been evident due to severe light attenuation from Piedmont-sourced turbidity and organic color from Coastal Plain tributaries. In July 2009 reports began of surface algal blooms stretching from the lower river into the upper estuary. Microscopy indicated the blooms consisted of the cyanobacterium Microcystis aeruginosa. The blooms produced dense surface scums of concentrated chlorophyll a, BOD, TN, TP and TSS. Taste and odor complaints forced water treatment facilities to increase treatment levels. The blooms ended in fall but recommenced in summer 2010 and summer 2011, which saw expansion of the blooms impacting over 65 river km; additional cyanobacterial (Anabaena) blooms occurred in the tributary blackwater Northeast Cape Fear River, leading to severe hypoxia. In summer 2012 blooms returned and expanded water column sampling revealed marked layering of chlorophyll and associated BOD, with strong correlations between those two parameters. Bloom samples collected and analyzed in 2009 and 2012 produced milligram quantities of microcystins LR and RR; well above WHO recommended standards. These blooms additionally produced members of a family of secondary metabolites called micropeptins, including two new members; micropeptins 1106 and 1120. The biological activities for these new molecules have not yet been determined however protease activity has been well documented for this family. Present state-required collection of integrated depth samples miss the majority of the bloom material; thus eutrophication criteria often do not apply despite evident toxin and hypoxia issues. After decades of nutrient inputs these blooms mark a changing paradigm for this system, bringing new threats to its use as a drinking water source, fishery and migratory fish pathway.

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TIDES COME AND GO BUT BAGS, BUTTS AND BOTTLES SEEM TO STAY: A QUARTER CENTURY OF OCEAN TRASH TRENDS

Collection and analysis of robust data is a critical component of any conservation initiative. Within the marine debris realm, citizen scientists have been collecting data for twenty-seven years as part of Ocean Conservancy's International Coastal Cleanup (Cleanup). Each September Cleanup data are collected at over 6,000 sites around the world and are aggregated into the Ocean Trash Index – a location-by-location, item-by-item analysis of debris on beaches and along waterways. The complexity of the Cleanup poses makes tightly controlled, replicated data collection a challenge but trends illustrate differences in consumption, recycling and adequacy of waste management infrastructure at a range of scales. Elected officials have increasingly moved to ban, tax, or charge fees for single-use plastic items because of the threat these items pose to marine life. Ocean Conservancy's Cleanup data have routinely been cited in these efforts as evidence of the most persistent debris types. To better inform these policy efforts, Ocean Conservancy recently redesigned its Cleanup data form, devoting more attention to material type for each trash item. With this greater degree of specificity, Cleanup Coordinators, resource managers, and policy makers alike will be able to build policy campaigns and support legislation with a greater level of confidence of what litters our beaches and waterways. Ocean Conservancy's new data form—combined with qualitative debris characterizations—can be a critical component of targeted prevention measures such as single-use product bans, producer responsibility schemes, and product design innovation.

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APPLICATION OF UNSTRUCTURED WAVE MODEL TO LAKE MICHIGAN AND ITS TRIBUTARY GRAND HAVEN

Like meteorological input (e.g. wind speed), and geological conditions (e.g. bathymetry, complex coastal lines), wave variables (e.g. significant wave height) also played a critical role on the coastal circulation and plume dynamics in Great Lakes and coastal ocean.
In order to accurately simulate the aspects of hydrodynamic process and the subsequent environmental issues, an unstructured SWAN (Simulation WAves Nearshore) model was configured and applied to Lake Michigan to understand the wind-induced significant wave height variations, which could provide remote wave information for local Grand Haven wave model. Horizontal unstructured grid and vertical sigma-layers were utilized to resolve complex coastal lines and variable bottom topography of both Lake Michigan and Grand Haven. To test the magnitude of significant wave height and wave direction near the inlets of Grand Haven and its nearshore region, we run a series of wave simulations that respond to hourly wind speed, bathymetry, and remote wave forcing. Some conclusions have been given, such as: wind above the deep water part (larger than 15 meter) had major impact on the significant wave height; when the wind speed was set to be zero to the region with the bathymetry of less than 10m,it was found that the wave height had a little variation between them. To better understand the influence of bathymetry to the wave dynamics, some ideal gentle slope model cases have been conducted. And the results indicated that bathymetry was crucial to the significant wave height and wave direction. Finally, a brief comparison between the application of unstructured SWAN model and FVCOM- SWAVE (Finite Volume Coastal Ocean Model-Surface WAVE) model has been given for the Lake Michigan/Grand Haven system. The accurate simulation of wave dynamics will be used to improve the understanding of the effect of wave and wave- current interaction to the Grand Haven nearshore circulation in the next step.

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MULTIPLE COMPETING STABLE STATES, ECOSYSTEM ENGINEERING, AND TIDAL MARSH RESPONSE TO ANTHROPOGENIC PRESSURES

Tidal landforms in lagoons and estuaries, in their pursuit of sea level rise, generate ubiquitous and robust bio-geomorphic structures emerging from the coupled dynamics of biotic and abiotic processes. In particular, we examine here marsh vegetation zonation through observations and modeling. We show that widely-occurring sharp zonation patterns result from the ability of vegetation to actively engineer the landscape by tuning soil elevation within preferential ranges of optimal adaptation. We find multiple peaks in the frequency distribution of observed topographic elevation, which correspond to multiple competing stable states and are the signature of biologic controls on geomorphodynamics. Interestingly, stable biogeomorphic equilibria tend to correspond to suboptimal rates of biomass production, a result coherent with recent observations. We then analyze the response of marsh systems to changes in the rate of sea level rise, nutrient concentration, sediment availability, and atmospheric CO2 concentration, to explore the relative impacts of foreseeable changes in forcings, with implications for the overall resilience of marsh systems to direct and indirect anthropogenic pressures.

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RE-VEGETATION FACILITATES RECOVERY OF SEAGRASS CARBON SINKS

Seagrass meadows are important global carbon sinks and rank among the ecosystems that play a key role on climate change mitigation. Seagrass extension is globally declining due to human impacts (e.g. eutrophication, dredging and harbour programs, climate change). It is estimated that 30% of global seagrass carbon sequestration capacity has been lost since the end of 19th century. The loss of vegetation also enhances the risk of CO2 emissions from the millenary carbon soil deposits. Revegetation of seagrasss meadows could accelerate the recovery of these natural carbon sinks, and prevent the erosion of old soil carbon storage. Likewise, seagrass revegetation of areas with suitable conditions for seagrass growth would help to increase the global extent of carbon sinks. Since seagrasses are clonal plants, seagrass vegetation is able to spread by itself from a single planted shoots or seeds, and thus restoration of the carbon sink would require relatively small planting effort. Yet, there is little information about the effectiveness of revegetation to restore seagrass carbon sinks. Here, we quantify the carbon sink development in a revegetated Posidonia australis meadow at Oyster Harbour (W Australia) for the last 20 years as well as the risk of a loss of soil carbon stock while seagrass vegetation was lost.

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AN APPLICATION OF AN NPZ MODEL TO A COASTAL UPWELLING ECOSYSTEM IN THE YUCATAN PENINSULA, MEXICO

The current study represents the first attempt to address the phytoplankton responses to a coastal upwelling event in the north-east Yucatan Peninsula (Mexico) under a dynamic model approach. The aim of this study is to evaluate the applicability of a simple NPZ model (nutrients-phytoplankton-zooplankton) to describe temporal changes in nutrients and plankton in the coastal upwelling ecosystem of Cape Catoche (NE Yucatan). An existent dynamic and compartmentalized NPZ model was modified and applied to our study site. Calibration of the model was performed both by using information about plankton behavior in upwelling-influenced pelagic ecosystems reported in the literature and by including observational data collected during a strong upwelling event (April-September) in the study site. Simulation results showed that slight changes in the velocity of upwelling induce a twofold increase in phytoplankton biomass, although only a relatively reduced increase in zooplankton biomass. Lowering in water temperature (-30% less) led to a decrease in phytoplankton growth rate and thus, a 13% reduction of phytoplankton biomass. On the other hand, phytoplankton biomass increased (19%) as PAR values got higher (30%). Sensitivity analysis suggested the model is particularly affected by phytoplankton growth rate and mortality rate, as well as by zooplankton maximum ingestion rate. In the Yucatan Peninsula the utilization of this type of ecological models is nonexistent and should be adopted as an alternative study tool.

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LINKING SPATIAL ASPECTS OF *ZOSTERA MARINA* GROWTH AND LOSS DYNAMICS WITH ENVIRONMENTAL DRIVERS IN CHESAPEAKE BAY, USA

Recent analyses of status and trends in Chesapeake Bay submerged aquatic vegetation (SAV) have focused on linear relationships between yearly SAV abundance and yearly representations of environmental parameters. However, SAV beds generally do not respond as units to regional conditions; instead, growth and loss processes may exhibit distinct spatial dynamics within beds and within geographic sub-regions. Similarly, vegetation may not be sensitive to seasonal mean conditions, but may instead respond in non-linear fashion to short-term phenomena. Using a 28-year SAV monitoring dataset we documented spatially-explicit patterns in Zostera marina growth and loss, and investigated the relationships between these sensitive metrics of grassbed change and similarly focused aspects of available water quality measurements. Water quality metrics included exceedance values for temperature reconstructed from a combination of continuous fixed-station records and periodically sampled but spatially extensive Bay-wide stations. Water quality variables relevant to stressors in specific growth seasons (e.g. turbidity and chlorophyll in spring) were derived by binning interpolated records by temperature range. Results indicate a high degree of spatial specificity in Z. marina's responsiveness to water quality, reinforcing the need to investigate SAV-water quality relationships using sensitive formulations of SAV abundance and relevant formulations of water quality variables.

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HYDRODYNAMIC MODELING OF TURNOVER TIMES IN MOBILE BAY, ALABAMA AND THEIR SENSITIVITY TO TIDES, FLUVIAL DISCHARGE, AND METEOROLOGICAL FORCING

Residence, exposure, and flushing times are examples of hydrodynamic timescales, and generally describe the physical mass transport within a water body. The response and spatial variability of these measures to tides, fluvial discharge, and local meteorology are investigated through hydrodynamic model simulations of Mobile Bay, Alabama using a two-dimensional depth integrated Advanced Circulation (ADCIRC) model. Mobile Bay is a shallow (mean depth 3 m), drowned river-valley, micro-tidal (mean range 0.4 m) estuary located on the northeastern coast of the Gulf of Mexico. Hydrodynamic model output is coupled with a Lagrangian particle tracking model to predict the trajectories of more than 30,000 discrete particles distributed throughout the study area. Hydrodynamic timescales are estimated and analyzed based on these results. Spatially-averaged timescales generally range from 4 to 130 days, with large standard deviations (± 30 days), depending on the magnitude of fluvial discharge and local meteorology. Spatially averaged timescales can be accurately predicted using a power law regression ($R^2 > 0.99$) and simple freshwater fraction methods, but only if meteorological forcing is neglected. The wide, long, and shallow Bay responds quickly to meteorological forcing, thus changing the average and spatially variable timescale values. The meteorological forcing is found to account for as much as 55% of the variability in hydrodynamic timescales as compared to cases with fluvial discharge and tides only. Flushing of the Bay is found to transition from tidally-enhanced to river dominated for $Q > 1000\ m^3\ s^{-1}$. Synthesized results suggest average to excellent flushing throughout much of Mobile Bay, and relatively poor flushing along the eastern shoreline, the mid-section of Bon Secour Bay, and in some areas of the Mobile-Tensaw Delta.

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ESTIMATES OF NATURAL SALINITY AND HYDROLOGY IN THE SOUTHERN EVERGLADES, FLORIDA: IMPLICATIONS FOR MANAGEMENT

The Greater Everglades Ecosystem has been altered by the management of freshwater thereby changing the hydrology in the marshes and salinity patterns in Florida Bay and impacting the water-based ecology. To effectively restore this system, it is important to establish science-based restoration targets for salinity and hydrology. We describe a process to develop those targets by coupling paleoecology and regression models. Paleoecological

investigations characterize the circa 1900 CE (pre-alteration) salinity regime in Florida Bay based on molluscan remains in sediment cores. These paleosalinity estimates are converted into time series estimates of paleo-based salinity, stage, and flow using numeric and statistical models. Model outputs are weighted using the Mean Square Error (MSE) statistic and then combined (synthesized). Results indicate that, in the absence of water management, salinity in Florida Bay would be about 3 to 9 salinity units lower than current conditions, with the largest differences in the central and north areas and the smallest difference in the west. To achieve the target salinity regime, upstream freshwater levels must be about 0.25m higher than what has been observed over the last few decades, requiring increased flow inputs to Shark River Slough and Taylor Slough of about 2.1 and 3.7 times the existing, respectively. This flow deficit is comparable to the average volume of water currently being diverted from the Everglades ecosystem by water management. The synthesized paleo-based Florida Bay salinity and upstream hydrology (stage and flow) represent target restoration conditions that can be used with greater confidence than individual core estimates.

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SEASONAL PATTERNS OF THREE KEY PHYTOPLANKTON SPECIES IN SAN FRANCISCO BAY

Working Group 137 of the Scientific Committee for Ocean Research (SCOR) was established to compile, compare and synthesize long-term observations of phytoplankton community variability in the world's estuarine-coastal waters. Tasks of WG137 are organized around a set of first-order questions, including: Do individual phytoplankton species have characteristic seasonal patterns expressed similarly across estuarine ecosystems? As a step toward answering this question we analyzed seasonal patterns of three key phytoplankton species in San Francisco Bay (SFB) based on 879 samples collected from 1992 to 2012. The diatom Skeletonema costatum is a cosmopolitan, often dominant, component of coastal phytoplankton biomass, and can develop large blooms in SFB. S. costatum has an annual spring bloom in the salty regions of SFB and an elevated baseline biomass year-round relative to other phytoplankton species. Although infrequently, S. costatum can also appear in fresher regions of the system suggesting it is a generalist estuarine species. The globally distributed, and biomass-dominant dinoflagellate in SFB, Akashiwo sanguineum, is detected in a minority of samples except during September-October when it blooms in regions with strong marine influence. Cryptophytes are ubiquitous estuarine flagellates, as is evident in SFB where Teleaulax amphioxeia occurred in 70% of all samples and across a broad salinity range (0-32). This was the highest frequency of occurrence of any of the 601 phytoplankton species in our dataset. T. amphioxeia demonstrated spatial and temporal variability with a regular spring bloom in the South Bay and a frequent fall bloom in the northern San Pablo Bay. These results provide a reference for comparing seasonal patterns of these species in long-term records from other systems being analyzed by WG137 members such as Hong Kong coastal waters, Chesapeake Bay, Danish fjords, and the Patos Lagoon.

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MANIPULATIVE EXPERIMENTS TEST EFFECTS OF INVASIVE *PHRAGMITES AUSTRALIS* AND NITROGEN ENRICHMENT ON GREENHOUSE GAS FLUXES

Increasing anthropogenic nitrogen inputs, now typical in New England salt marshes and other coastal wetlands worldwide, may change salt marshes from sinks to sources of the potent greenhouse gas N2O and may facilitate invasion by exotic species such as Phragmites australis. Phragmites is one of the world's most widespread invasive plants, and its migration into New England salt marshes has been well-documented. Phragmites' large aerenchyma and impacts on rhizosphere conditions may alter microbial community dynamics and the plants may serve as conduits between the rhizosphere and atmosphere. Therefore, Phragmites invasion may affect marsh greenhouse gas fluxes. To determine the effects of nitrogen addition and Phragmites presence, greenhouse gas fluxes were compared between fertilized and unfertilized mesocosms containing either Phragmites or the native salt marsh grass Spartina patens. Subsets of mesocosms containing plants of each species were subjected to 27.43 mg of nitrogen per square meter per day for three months. Greenhouse gas (CO2 and N2O) fluxes from mesocosms were measured using CRDS in situ analyzers and gas-tight chambers at two stages of plant development (early growth and mature). Measured CO2 and N2O fluxes were significantly higher from mesocosms containing Spartina than from those containing Phragmites at both stages of plant development. Plant development stage affected fluxes, with CO2 fluxes showing a significant increase as Phragmites plants matured, and N2O fluxes decreasing significantly as Spartina plants matured. The results of this on-going study, though preliminary, emphasize the importance of considering the impacts of plant species, succession and biomass as mediators of greenhouse gas dynamics.

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A VIEW FROM THE SOUTH: CONCLUSIONS ON THE CERF INAUGURAL CONFERENCE OF THE AMERICAS

Last November 2012 CERF celebrated its first conference outside the US in Mar del Plata, Argentina under the title "The Changing Coastal and Estuarine Environment: A Comparative Approach." The conference provided a unique formal opportunity for true interaction among scientists from the southern and northern hemispheres to synthesize understanding within this context. The conference was geographically broad including scientists from 16 countries. Among the attendants, 57% were from South America, 37% from North America, and 6% from other continents (Europe, Asia, Australia). The participation of students was high reaching a total of 44% among the attendants. Fifty percent of the presentations from North America were within the "Land-sea coupling in rapidly changing environment" session while those from South America were more numerous in the "Fishery Exploitation" session and as posters in the "Biological interactions" session. We will discuss potential causes (e.g. differential importance of sea level rise, UV effects, anthropogenic nutrient input) of the difference in the themes being addressed from scientist working in the south with those from the north. As post-conference results we highlight: 1) a special issue in Estuaries and Coasts including reviews and articles by authors from North and South America, 2) a session in the San Diego conference dedicated to South and Central American estuaries and coasts, and 3) the formation of a social media group to promote connections among students from the Americas that is currently in use and very helpful to promote CERF's news. These results highlight the importance of developing international meetings to fortalice links among scientists. Both keynote speakers in the Mar del Plata conference highlighted the importance to work interdisciplinary and within a global change context, for this reason we celebrate CERF initiative and we encourage CERF to keep doing this kind of international conference in the future.

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INTEGRATING CO_2 AND NUTRIENT-DRIVEN CHANGES ACROSS ENTIRE SEAGRASS ECOSYSTEMS: FROM PLANT STOICHIOMETRY TO ECOSYSTEM CARBON SINK

We investigated the scaling up of the effects of elevated CO_2 and nutrients from the quality and quantity of marine primary producers to the community /ecosystem level, through food web and detrital pathways. We tested the response of two different seagrass communities of *Zostera noltii*, adapted to low and high nutrient levels, in a 6 weeks mesocosm experiment. In meadows adapted to low nutrient levels, eutrophication exhibited a faster and stronger effect than CO_2 levels predicted for the end of the century. Both CO_2 and eutrophication enhanced epiphyte overgrowth and lead to an important loss of the carbon sink capacity of the meadow, but a compensatory interaction of CO_2 and nutrients attenuated their isolated effects. In the meadow adapted to high nutrient levels, overgrazing by herbivorous amphipods was the most striking component of an abrupt ecosystem state shift. This shift was unrelated to the experimental treatments but linked to plant-specific vulnerability to herbivory. In conclusion, this study revealed that elevated CO_2 may not enhance seagrass productivity as certainly as previously thought, since this effect is dependent on the interaction with local eutrophication and on factors determining epiphyte proliferation and susceptibility to herbivory. This supports the importance of designing approaches that incorporate both interdependencies among species and the complexity of responses to multiple stressors to endorse future conservation efforts.

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BALANCING ECOLOGY, MANAGEMENT AND SCIENCE IN THE RUSSIAN RIVER ESTUARY

Intermittent estuaries are ecologically dynamic environments and the policy and management questions surrounding them are equally dynamic. Recreation, housing, and tourism demands on estuaries must be balanced with regulatory policy directives to manage these environments for a suite of ecological needs, including restoration of habitats that can lead to recovery of endangered species populations. The Russian River estuary in Sonoma County, California, provides a case study of an intermittent estuary where balancing ecological needs for enhancing habitat for listed fish species with dependent human dimensions (minimizing flood risk to existing infrastructure, maximizing/sustaining recreational demands) requires development of scientific understanding of the physical and

ecological processes of the estuary. We will discuss perspectives and challenges related to how one can manage an intermittent estuary to enhance habitat for juvenile steelhead rearing habitat while simultaneously minimizing flood risk, continuing to meet the needs of other species, and sustaining other ecological services (including water supply) – and we will outline scientific approaches and successes in addressing key questions in this case-study system.

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LOCATION, LOCATION, LOCATION! SPATIAL HETEROGENEITY OF SALT MARSH BIOGEOCHEMICAL PROCESSES

We quantified soil biogeochemical processes (nitrification potential, phosphorus sorption, greenhouse gas fluxes) and soil properties in oiled and unoiled Louisiana marshes following the Deepwater Horizon oil spill. We sampled along transects from the marsh edge to interior in 13 marshes across three regions (Terrebonne Bay (TB), western (WB) and eastern Barataria Bay (EB)). Nitrification potential and soil greenhouse gas fluxes were measured in TB monthly from May to September 2012. Nitrification potential was also measured across all regions in July and September and phosphorus sorption in September 2012. We observed distinct spatial patterns within individual marshes in each region. In Terrebonne Bay, nitrification potential, CO2 flux, phosphorus sorption, and several soil properties (e.g., soil organic matter, organic C, extractable Fe, Al, and PO4-P) all increased from the marsh edge to the marsh interior. Conversely, nitrification potential and soil properties decreased with increasing distance from the marsh edge in WB sites. Finally, there were no apparent spatial patterns in the eastern Barataria marshes. Biogeochemical processes exhibited very high degrees of variability across sampling events, with nitrification, phosphorus sorption and net greenhouse fluxes varying up to 1, 3, and 3 orders of magnitude, respectively. Interestingly, the variability within individual marshes was often as high as observed across all sites. We will address the question "How do we accurately characterize salt marsh biogeochemical functions?" by comparing our spatially integrated results with those generated by sampling at discrete distances from the marsh edge across sites and time. This study highlights the importance of considering spatial heterogeneity into consideration when designing sampling approaches.

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AN APPLICATION OF A HYDRODYNAMIC MODEL IN THE SAN FRANCISCO-BAY DELTA: INSIGHTS INTO THE IMPACT OF RAPID SEA LEVEL RISE ON REGIONAL HYDRODYNAMIC AND SALINITY FIELDS

The San Francisco Bay and Sacramento–San Joaquin River Delta have intricate topography, bathymetry, and hydrology patterns, leading to complex hydrodynamic, salinity and turbidity fields. The interconnected nature of climate, hydrodynamics, sediment, salinity and biology in this region has prompted a similarly interconnected study to assess the impacts of changes in stressors on these fields. The USGS-led CASCaDE II project aims to understand how changes in climate and physical configurations impact water quality, ecosystem processes, and key species in the Delta through the application of a series of linked models of climate, hydrology, hydrodynamics, sediment, geomorphology, phytoplankton, bivalves, contaminants, marsh accretion, and fish. The 3D, flexible-mesh, hydrodynamic model D-Flow FM, developed by Deltares, has been applied to the Bay and Delta as part of the CASCaDE II project. The model configuration extends from Point Reyes to Sacramento in the north and Mossdale in the east, and utilizes curvilinear grid elements, and unstructured triangles and pentagons for improved alignment along main flow directions and more natural depictions of irregular shorelines. Configuration also allows for the flooding of below sea-level leveed islands for the study of tidal propagation and transport in these areas. The parallel model is computationally scalable in high-performance computing environments, and will be applied to long (up to 100 year) climate scenarios incorporating large planned and unplanned physical changes in the region. Physical changes, along with regional climate changes, can have significant impacts on water quality and the Delta ecosystem. One key issue is potential change in salinity distribution due to coastal sea level rise, and the cascading effects on water quality, habitat and key Delta species. In this presentation, model application will cover a rapid sea level rise scenario and the effect on hydrodynamic and salinity fields in the estuary.

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SHORT TERM MORPHODYNAMICS OF THE PUNTA BANDA COASTAL LAGOON, ENSENADA, BAJA CALIFORNIA

The Estero de Punta Banda (EPB) is a small L shaped coastal lagoon with an average depth of 2m and a total area of 360 Ha. The tide is semidiurnal with a maximum range of 2.2m. Two intermittent streams drain into the EPB during the winter months which occasionally input significant amounts of medium- sized sand into the system. The Arroyo San Carlos (which is closer to the mouth) drains an average of 231,000m3 of sediment per year. During the last two decades the inlet has significantly migrated towards the north, causing erosion to a developed area and the need for coastal protection. More recently (2011-2012), sporadic observations have been undertaken at the mouth and significant changes to the mouth morphology as well as to the access channel have been reported. However, no quantitative analysis have been done to determine the causes of such migration and under which climatic-Oceanographic conditions such changes occur. The focus of this study is to quantify volume changes as well as morphodynamic changes of the mouth and delta of the EPB through repetitive bathymetric surveys as well as numerical modeling using CMS-Flow and CMS-Wave and determine the forcing conditions for such migrations (combination of runoff, tides and wave climate).

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BACTERIAL, FUNGAL, AND PARASITIC INFESTATION IN MALAYSIAN HORSESHOE CRABS

Three out of four species of horseshoe crab in the world found in Malaysia are Tachypleus tridentatus, T. gigas and Carcinoscorpius rotundicauda. Presently in Asia, the first two species are being utilized in the production of Tachypleus amebocyte lysate (TAL), an important kit in the biomedical industry. This kit has a similar function to that of Limulus amebocytes lysate (LAL) kit, a product derived from the Atlantic horseshoe crab, Limulus polyphemus. Unlike in the United States, the harvest of horseshoe crabs in Asian countries is still unregulated. Monitoring program and regulative measures are only implemented by very few Asian countries like Japan, Taiwan and Hong Kong. In Malaysia, reduction of horseshoe crab sightings in its natural habitat has prompted studies on some of the biological aspects of this invertebrate. Successful incubation of T. gigas eggs has resulted in the culture of its larvae in laboratory condition. A comparative study was carried on eggs and newly hatched T. gigas collected from a natural spawning in Banting, Selangor (Malaysia) showed evidence of fungal and bacterial infestation. These microbes were found on the eggs and larvae surface. Species identified were Aspergillus sp., Aspergillus niger, Peniclillium sp., Gliocladium sp. for fungus, while Shewanella putrefaciens, Bacillus cereus, Corynebacterium sp. and Enterococcus faecalis for bacteria respectively. Eggs infected with fungus usually will turn reddish, grey or black and cease to develop, meanwhile larvae became passive and coated with black spore. A parasite identified as Ectoplanaria sp. was found on the prosomatic appendage of C. rotundicauda. Key words: Bacteria, Eggs, Fungus, Infection, Larvae, Parasite

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PHYTOPLANKTON PRODUCTIVITY AND DYNAMICS IN A SHALLOW, MICROTIDAL, EXTENSIVELY MODIFIED SUBTROPICAL ESTUARY ON THE SOUTHWEST COAST OF FLORIDA, USA

Urban and agricultural development in and around the Caloosahatchee Estuary on the southwest coast of Florida in the USA has altered the flow and quality of water in the system since the late 1800s. Increasing algal blooms have brought attention to water quality and processes affecting phytoplankton production and biomass accumulation there. The primary objectives of this project were to (1) measure phytoplankton productivity to test a previously developed empirical model based on simple measures of phytoplankton biomass and light

availability in the photic zone and (2) apply the phytoplankton productivity model to analyze long-term shifts in and influences on the estuary's trophic status. The model test was conducted using integrated water samples collected monthly between February 2009 and August 2009 at four sites (one in each region of the estuary and bay). Primary production rates, in terms of oxygen evolution, were measured using simulated *in situ* light:dark bottle incubations in a flow-through raceway. When the estimates from all four sites were pooled there was a strong linear relationship between daily gross primary productivity (GPP_d) and the 'light•biomass' model predictor ($r^2 = 0.84$, $p<0.001$). The influence of secondary factors on the productivity potential of the phytoplankton community and, thus, the trophic status of the Caloosahatchee Estuary was examined by applying the model relationship over twenty-five year period using a water quality data set compiled there between January 1986 and December 2010. Estimates of annual gross primary productivity (GPP_y) averaged 253 $g•C•m^{-2}•yr^{-1}$ overall and varied spatially and temporally from oligotrophic (less than 100 $g•C•m^{-2}•yr^{-1}$) to hypertrophic levels (greater than 500 $g•C•m^{-2}•yr^{-1}$). A combination of both natural and anthropogenic drivers representing the role of climate and weather, nutrients, and light quality provided the best correlation to the long-term patterns in productivity.

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INDIVIDUALS WITHIN A DIVERSE PREDATOR GUILD SERVE AS MOBILE LINKS BETWEEN DISPARATE HABITATS OF A COASTAL ESTUARY AND ADJACENT MARINE WATERS

Ecosystems are often comprised of geographically distinct habitats, and understanding how disparate habitats are connected is important for gaining insight into ecosystem dynamics. Trophic interactions can link habitats, and when highly mobile predators use multiple habitats within and across ecosystem boundaries, they can transport biomass and nutrients and connect multiple food webs. Such dynamics may be especially important in nutrient-limited systems. The Shark River Estuary, Florida, USA is an oligotrophic ecosystem that stretches from the Gulf of Mexico to freshwater marshes, and provides habitat for a variety of predators, including American alligators, American crocodiles, bottlenose dolphins, bull sharks, snook, and tarpon. Through our research using a variety of sampling techniques, including acoustic and GPS tracking, mark-recapture, stable isotope analysis, and stomach content analysis, we have found that the habitat use of each predator population extends throughout estuary, and at least alligators, sharks, and snook feed on prey from multiple food webs. As such, these predators serve as mobile links between marine, brackish, and freshwater areas of the estuary, and their respective food webs, however the spatial and temporal scales over which each predator population connects these food webs and impacts recipient habitats varies, suggesting each has a unique role within the ecosystem. Through our research we hope to increase our understanding of the role predators play in linking disparate habitats, which is important as natural and anthropogenic drivers continue to alter ecosystem structure and the roles animals have within them.

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A UNIQUE APPROACH TO UNDERSTANDING *LIMULUS* POPULATION DYNAMICS IN THE LONG ISLAND SOUND ESTUARY

Long Island Sound (LIS) is the second largest estuary on the east coast of the United States with over 8 million people living in its watershed and producing over $5.5 billion per year to the regional economy through boating, commercial and sport fishing, and tourism activities. A healthy and expanding horseshoe crab population is an important part of this economy. *Limulus* has numerous important ecological links within the Sound as well. We have been investigating the life history and population ecology of the American Horseshoe crab (*Limulus polyphemus*) in the Sound for 15 years with the goal to improve the management and harvest of the population. We trained a core group of volunteers associated with non-profit conservation organizations to help gather data on local beaches. Through this volunteer network, over 77,000 horseshoe crabs have been tagged with over 12,000 reported recaptures, a 15% recapture rate. Mark/recapture analyses reveal that 98% of crabs tagged in LIS are recaptured in LIS. *Limulus* exhibits moderate spawning site fidelity (~50%) but also tends to move randomly around the Sound across numerous years. An analysis of 14 microsatellite loci from 5 widely dispersed sample populations revealed no subpopulation structure and supports the tag/recapture data demonstrating that the population within the Sound is panmictic. Even after years of heavy harvesting and population decline there was no evidence of inbreeding depression. Five years of spawning census data show spawning indices to be 3-4 orders of magnitude lower than Delaware Bay. Spawning surveys also indicate that the spawning population is relatively stable with annual variation. Recent analyses between beach geomorphology and spawning indices show no significant correlation between grain size, beach slope, beach width and spawning indices. How this methodology can be used to study Asian horseshoe crabs will be discussed.

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PROJECT LIMULUS: SPECIES CONSERVATION AND THE WEB OF KNOWLEDGE SURROUNDING THE LONG ISLAND SOUND ESTUARY

Project *Limulus* (www.projectlimulus.org) is a research program investigating the population dynamics of horseshoe crabs in Long Island Sound (LIS). Our program builds a web of knowledge with professors teaching and mentoring graduate and undergraduate students. We set up partnerships with nonprofit conservation organizations that educate and update the staff of these organizations. The information is then disseminated to the public with the students actively participating in all aspects of the research and outreach. This collaborative research effort, involves federal, state, nonprofit, and community groups while promoting science literacy across all age groups. More specifically, over the past ten years we have focused on the genetic diversity of the horseshoe crab population, migration patterns, mating behaviors, assessment of spawning success, and ecological links to other species in LIS. Additionally, we run outreach programs for elementary and high school classes that includes lesson plans for pre- and post- fieldtrip activities. Our students go into the classroom and help teachers with the program and then help lead the field trips. With support from Disney Worldwide Conservation Fund we have shown how research links math and science education and can excite kids about learning science. We produced tagging kits that will make it easier to train teachers and students how to tag horseshoe crabs and collect data for our study as well as their classroom activities. We have promoted the science literacy aspect of Project Limulus for over 10 years now through the help of the Connecticut Audubon Society, The Maritime Aquarium, Mystic Aquarium, SoundWaters, and The Nature Conservancy and many others. How we find time to both educate and conduct research will be discussed.

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A FIELD TEST OF RESILIENCE: MEASURING FEEDBACK PROCESSES IN SEAGRASS ECOSYSTEMS FOLLOWING A FLOOD

Theoretically, the resilience of ecosystems to major and potentially irreversible regime shifts is supported by feedback loops that promote self-organisation and resistance to small disturbances. However, while the theory behind ecosystem resilience is becoming increasingly refined, there are few practical methods for applying it and measuring it in the field. We have developed a practical framework focused on the measurement of feedback processes to provide a test of regime resilience. The framework is based on predictable relationships between key components that are inherent in all ecosystem regimes: impacts, feedback processes and regime response variables. The three components are interrelated, and impacts ultimately affect response variables with feedback processes mitigating that effect. Variations in response variables alter the strength of feedback processes which in turn alter their mitigating effect on impacts. We applied the framework in a seagrass dominated ecosystem following a flood in Queensland, Australia, by testing the hypothesis that the proximity to the flood impact will affect the relationships between ecosystem components. We measured processes from three feedback loops, the uptake of nutrients from the water column, the trapping of water column sediments and grazing rates on algae following the flood in Jan 2011. Immediately following the flood, grazing rates and sediment trapping levels were higher at locations inside the flood plume, resulting in no significant change in seagrass biomass. In contrast, the rates of the three feedback processes at meadows outside the flood plume remained low, resulting in significant decreases in seagrass biomass. Our results provide empirical evidence that feedback processes vary in response to disturbance. We show that variation in morphological and physiological characteristics between meadows inside and outside the flood plume explain the differences in relationships between ecosystem components.

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ADDRESSING MULTIPLE MARINE DATA NEEDS FROM LOCAL TO NATIONAL SCALES: THE NANOOS/IOOS REGIONAL CASE ILLUSTRATED WITH OCEAN ACIDIFICATION APPLICATIONS

The Northwest Association of Networked Ocean Observing Systems (NANOOS), the Pacific NW Regional Association of the United States Integrated Ocean Observing System (IOOS), focuses on the integration and timely delivery of marine data to serve the needs and decisions of its region in a nationally coordinated fashion. NANOOS collaboratively leverages limited resources to address multiple thematic areas of emphasis. It aggregates and serves meteorological and oceanographic data derived from observation platforms such as buoys, tide gauges, weather stations, gliders, cruises, high-frequency radar and satellites, as well as model forecast information. It also serves geospatial map data on shoreline change, tsunami inundation risk, coastal infrastructure, etc. These data originate from a wide range of providers including federal, state, tribal and municipal entities, and the private and academic sectors. This diversity of needs, applications, providers and data types has led to the development of a multifaceted data integration strategy that strives to balance data types and data-provider capabilities with prioritized user and system demands. In common with the core IOOS mission, the primary data subset involves dynamic data streams transmitted in near-real-time and made available through both user-friendly online applications and interoperable data services compliant with IOOS-supported standards. However, the provision of other important data subsets is often driven largely by user demand for visualization access via online applications. We will describe strategies adopted by NANOOS to maximize data access in a manner that is responsive to known user needs and system integration requirements, in the context of limited resources and evolving partnerships. These approaches will be examined in depth by focusing on data efforts stemming from partnerships with shellfish growers, scientists and resource managers grappling with the impact of ocean acidification.

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SEAGRASS MEADOWS ARE SIGNIFICANT DEPOSITS OF CARBONATE

Particulate inorganic carbon (PIC) represents about 1/4 of all marine sediments. Calcium carbonate production and storage has been comprehensively assessed for a range of benthic ecosystems such as coral reefs and coralline algae formations but not for seagrass meadows. Carbonate dynamics identified in seagrass meadows, for example, particle sedimentation fluxes, calcifying epiphyte loads and daily process of calcification/dissolution suggest that seagrass meadows could also store significant carbonate stocks that could have been underestimated. Seagrass meadows have been recently identified as key ecosystems for climate change mitigation and adaptation due to their important contribution to carbon sequestration and storage of organic matter (Corg) in the sediment while enhancing sediment accretion. Whereas the contribution of Corg has been assessed, the particulate inorganic carbon (PIC) pool remains unexplored. The goal of this study was to provide a first global assessment of the PIC deposits existing in the top meter of seagrass sediments, and explore their variability across latitude, seagrass species and sediment depth. We compiled all the data available on CaCO3 content in seagrass sediments. We found that PIC stocks exceeded, by nearly five times, those of Corg, decreased with increasing latitude and accumulated in the sediments at rates (t y-1) similar to those in coral reefs. These results demonstrate that seagrass meadows are significant carbonate sinks and that their role in the oceanic carbonate budget has been underappreciated.

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SALINITY INTRUSION INTO THE MISSISSIPPI RIVER NEAR NEW ORLEANS, LA

Mississippi River flow below New Orleans, LA, occasionally is low enough that salt water from the Gulf of Mexico intrudes far enough inland to be of concern to users of fresh water from the river in the Greater New Orleans region. Since the estuary is generally of very low energy, especially during periods of low river flow, the lower river becomes highly stratified, with a distinct salt wedge moving up the river along the bottom until an equilibrium point is reached. When the toe of the salt wedge encounters a high spot, or crossing, in the river, it is arrested, and it cannot intrude further upstream until or unless the salt water piles up high enough and flows upstream over the high spot. Several times, an artificial high spot, or berm, has been placed in the river to arrest the progress of the upstream movement of the wedge when fresh water intakes are thought to be at risk. The placement of these berms depends, in part, on analyses performed in the 1980's. This talk will present results of new three-dimensional numerical modeling to update and improve the tools used to place the berms in the face of sea level change and other issues that have arisen since the original work.

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NUMERICAL MODELING OF THE TERREBONNE BASIN IN SOUTHERN LOUISIANA

Numerical modeling in southern Louisiana can be very challenging due to the complex nature of the area. The extensive connectivity and significant wetting/drying that occurs in southern Louisiana marshes and bayous makes accurate modeling of the area extremely difficult. Model studies are also challenging due to the limited amount of bathymetric data and measured hydrodynamic and salinity data. The Adaptive Hydraulics (AdH) code was utilized to create a validated model for the Terrebonne Basin in southern Louisiana. The study area is extensive in size and fed by the Atchafalaya River. This model included hydrodynamic and salinity transport and was utilized to investigate the impacts of system alterations on the base conditions and analyze the impacts of sea level rise.

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NUTRIENT AND ORGANIC MATTER DYNAMICS IN SEASONALLY OPEN AND CLOSED LAGOON ECOSYSTEMS ALONG THE EASTERN ALASKA BEAUFORT SEA COAST

Water exchange between the open ocean and lagoon ecosystems along the eastern Alaska Beaufort Sea coast is constrained by shallow channels through shifting sand barriers and seasonal sea ice growth. As ice thickness grows in the fall and winter, water exchange is increasingly restricted, with some lagoons becoming completely disconnected from the ocean for several months per year. Data collected from these remarkable ecosystems using in-situ sensors (year-round) and water sampling during April (ice covered), June (ice break-up), and August (open water) show that salinities can reach as high as 50 in the winter. Runoff and sea-ice thaw in the spring create highly stratified conditions, with hyper-saline bottom waters persisting through the summer in some locations. These variations in physical conditions are accompanied by variations in inorganic nitrogen and organic matter within the lagoons. High concentrations of ammonium, and to a lesser extent nitrate, build up under the ice during the winter months. These nutrients are rapidly depleted during the ice break-up period and remain low throughout the summer. Concentrations of dissolved and particulate organic matter peak during the ice break-up period, but proportional contributions of terrestrial organic matter are highest in late summer. This elevated terrestrial organic matter signal is most pronounced in the particulate pool. We hypothesize that although terrestrial runoff is highest in the spring, contributions of land-derived organic matter increase relative to contributions from local production as the summer progresses because inorganic nutrients

regenerated over the winter that support local production become depleted following break-up. This work is part of a broader effort to understand the role of terrestrial inputs as resources supporting microbial and metazoan food webs along the eastern Alaska Beaufort Sea coast.

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LOUISIANA COMMERCIAL FISHING INDUSTRY RESPONSE TO THE DEEPWATER HORIZON OIL SPILL

The Deepwater Horizon oil spill (20 April – 15 July 2010) and resulting mitigation efforts (dispersants and freshwater diversions) have been predicted to significantly lower fisheries landings and revenue in the Gulf of Mexico. In 2009, the Louisiana commercial fishing industry harvested over 1 billion pounds of fish, second in the United States only to Alaska, and generated nearly $250 million in revenue. Yet, there has been minimal research on how the decreased catches of several important commercial species (shrimp, oyster, and blue crab, which combined constitute over 70% of the total revenue) may change the commercial fishing industry of Louisiana as a whole and whether the change will be permanent or temporary. We used data collected on landings, value, trips, vessel size, and gear type from commercial fishery trip tickets provided by the Louisiana Department of Wildlife and Fisheries. These data were used to determine the trajectory of recovery of the industry temporally and spatially from the oil spill. The data were separated by basin and aggregated monthly from 2000-2012. Preliminary results suggest that as areas affected by the oil spill were closed to fishing, fishing pressure increased in areas to the west, which were unaffected by the oil spill and subsequent fishing closures. Fishing did not cease with the oil spill, but rather shifted to different basins. We will also use independent fishery datasets to determine if they accurately reflect variability in the commercial fishing industry.

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INTERTIDAL FORAGING HABITS OF FISHED AND PROTECTED CALIFORNIA SPINY LOBSTERS OF CATALINA ISLAND, CALIFORNIA

Managers have increasingly resorted to marine protected areas to combat overfishing of valuable species like the California Spiny Lobster (Panulirus interruptus). Both in and external to these protected areas, rocky intertidal zone serves as an important nighttime high tide foraging habitat. There, lobsters feed upon mussels, crabs, and limpets. But on Catalina Island, variation in the prey these lobsters target may reflect variation in their abundance and size structure driven by variable prey availability or spatially variable protection from fishing. We compared the trophic level of protected and fished lobster populations by measuring their isotopic signatures (e.g. carbon and nitrogen stable isotopes). We also inferred the relative importance of each of three species that largely comprise spiny lobster diet in this region by applying the isotopic signature data to Bayesian mixing models. We predict that protected spiny lobster muscle tissues will exhibit depleted δ15N, indicative of feeding at a lower trophic level. Mixing models may indicate variation in the order of importance of prey species between fished and protected sites and between sites with and without mussel beds, a key foraging habitat for lobsters. The strategy of closing areas to fishing can impact local trophic dynamics but habitat quality, regardless of fishing pressure, remains an important factor in determining prey availability and community trophic dynamics. For coastal management, this study highlights the value of incorporating a variety of habitats, such as intertidal mussel bed habitat, into the design of marine reserves.

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GROWTH AND MORPHOLOGICAL PLASTICITY OF *THALASSIA TESTUDINUM* IN THE GULF OF MEXICO

The seagrass *Thalassia testudinum* is ubiquitous in the Gulf of Mexico and numerous physiological and ecological studies exist. However, there are few large-scale studies that compare populations exposed to natural gradients in stressors throughout the species' range. Such studies are important to gain new insights on the plasticity of the species and its ability to respond to increasing stress. In this study, we compared morphological, demographic, phenological, and physiological characteristics of three separate *Thalassia* populations from three disparate areas in the Gulf: Perdido Bay, FL, Corpus Christi Bay, TX, and Long Key, FL. These areas differed primarily in benthic light penetration, salinity fluctuations, and SST fluctuations. Morphological plasticity was high among the three areas, with blade length and width being defining characteristics. Individual short shoots were oldest on average in Long Key and youngest in Corpus Christi Bay. The shoots also flowered more frequently and at an earlier age in the Northern Gulf. Shoots from Northern Gulf areas had higher total chlorophyll content on average. The Corpus Christi population had the highest average vertical shoot growth rate, while Long Key shoots had the highest horizontal rhizome growth rate. These characteristics can be used in population life history strategy determinations for managers and researchers alike.

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POPULATION GENETIC STRUCTURE AND SPATIAL DELINEATION OF THE SEAGRASSES *THALASSIA TESTUDINUM* AND *HALODULE WRIGHTII* IN THE GULF OF MEXICO NEAR THE FLORIDA AND ALABAMA COASTLINES

The genetic diversity of the seagrasses *Thalassia testudinum* and *Halodule wrightii* collected from three locations (St. George Sound, FL; St. Joseph Bay, FL; and Grand Lagoon, FL) was estimated using microsatellite markers. The objective of this preliminary study was to measure the extent of monoclonal genotypes within sampled sites and to estimate gene flow among sampled sites for the two species. Seagrass tissue samples were collected at 10 meter intervals along 100 meter transects. The tissues were preserved in silica gel and transported to Kennesaw State University for genetic analysis. Whole genomic DNA was isolated from plant tissue using MOBIO DNA Extraction Kit. Six microsatellite loci for each species were amplified. The amplified samples were electrophoresed using an ABI 310 automated DNA sequencer. The allele sizes were estimated compared to an ROX 500 size standard and the genotypes assigned using GENESCAN (ABI) software. Allelic diversity was detected within loci, among individuals, within sites and between sites indicating site specific genetic differences. Monoclonal genotypes ranged from 10 to 100 meters for the two species and varied within and between sampled sites. Additional samples are currently being obtained from other locations along the Florida and Alabama Gulf Coast and DNA sequence data will be collected. The observed patterns of genetic diversity and the natural barriers and corridors of recruitment in this system for these species will be interpreted in the context of natural and anthropogenic impacts on seagrass beds. Knowledge of this type will enhance the ability of researchers to predict if and how this species and others will respond to changes in hydrology and disturbance, and the impact these changes may have on community structure.

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ANALYTICAL DATA TOOLS EMPLOYED BY LOUISIANA'S COASTWIDE REFERENCE MONITORING SYSTEM

The Coastwide Reference Monitoring System (CRMS) is a comprehensive, standardized network of 392 monitoring sites that evaluates restoration projects and informs restoration planning throughout Louisiana's coastal zone. Hydrologic, vegetation, and soil data types are collected at each site to monitor ecological factors important to wetland sustainability. Hydrologic measurements include hourly water elevation and salinity and monthly soil porewater salinity. Emergent vegetation composition is measured annually at each CRMS site and includes cover of each species and height of dominant species and vegetative layers including carpet, herb, shrub, and tree. Soil bulk density, % organic, and % mineral matter are collected decadaly at each site. Surface elevation change and vertical accretion are measured bi-annually at all sites that are not floating or constantly flooded, flocculent swamps. The CRMS Analytical Teams combine data into analytical tools to assess the condition of sites and projects for the restoration community. The Hydrologic Index (HI) indicates how primary productivity at a site will likely respond to mean annual salinity and percent time flooded. The Floristic Quality Index (FQI) assesses the fidelity of a vegetative community to a habitat type; invasive species receive lower scores than native species indicative of habitat stability. The Forested FQI (FFQI) utilizes the basal area of trees and species fidelity for swamps. The Vegetation Volume Index (VVI) combines layer cover and height to provide a surrogate for vegetative productivity. The Submergence Vulnerability Index (SVI) assesses a site's vulnerability to submergence due to sea-level rise using elevation change, subsidence, and water elevation data collected at each site. Charts created from each data type and indicies are available at the CRMS website (lacoast.gov/crms2/home.aspx) where charts are delivered through dynamic mapping and chart building interfaces.

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SEAGRASS RESTORATION ENHANCES "BLUE CARBON" SEQUESTRATION IN COASTAL WATERS: STATE CHANGES AND TIPPING POINTS

The Virginia coastal bays experienced a dramatic ecosystem state change in the last century with the wholesale loss of seagrass (eelgrass, Zostera marina) due to storm impacts on populations already weakened by disease. This state change to an 'unvegetated' bottom dominated by benthic algae resulted in the loss of critical ecosystem services provided by seagrasses. A large-scale restoration program by seeding has resulted in 1000's of acres of healthy seagrass, and provides a model system to understand the return of ecosystem services by following seagrass recovery in shallow coastal ecosystems. Through long-term monitoring of plant and sediment parameters, we have docmented the recovery trends of replicate large (0.5 – 1.0 acre) plots ranging in age from 1 – 12 years. The change over time in seagrass aerial productivity and carbon sequestration is driven by an increase in shoot density, with the greatest rate of change observed 4 years after seeding. By 10 – 11 years after seeding, the restored meadows were net heterotrophic and were burying carbon in sediments at rates slightly below those recorded in extant seagrass meadows worldwide. By 12 years since seeding, seagrass meadows appear to have reached steady state with respect to shoot density and productivity, and sediment carbon burial rates are predicted to fall within the range of natural meadows. This is the first demonstration of the role of seagrass restoration as in enhancing "blue" carbon sequestration in coastal waters. Model results show that future environmental changes (light, temperature, nutrients, storm disturbance) will alter the maximum depth limit as the "tipping point" for seagrass survival, seagrass meadow resilience, and thus its ability to sequester carbon.

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SPATIAL AND TEMPORAL VARIABILITY OF THE MESOZOOPLANKTON COMMUNITY IN RELATION TO THE CHLOROPHYLL MAXIMUM OF THE NEUSE RIVER ESTUARY, NORTH CAROLINA USA

Estuarine phytoplankton accumulate in distinct zones referred to as chlorophyll maxima (CMAX). A distinct CMAX exists in the Neuse River Estuary (NRE), North Carolina, where more than 60% of the estuary's phytoplankton biomass is located. Little is known about the relationship between mesozooplankton grazers and the CMAX feature. We estimated the seasonal variability in mesozooplankton abundance and species composition in relation to the CMAX in the NRE over several years. A distinct CMAX was found in the NRE across all years and seasons. The CMAX was located in the oligohaline to mesohaline area of the estuary, depending on environmental conditions. Larger mesozooplankton (> 200μm) were not found to be spatially coincident with CMAX, rather these mesozooplankton were found further downstream in high abundance. The large mesozooplankton community was dominated by the calanoid copepod Acartia tonsa. Smaller mesozooplankton (> 60μm) were present throughout the estuary and showed no spatial differences with respect to the CMAX. The smaller mesozooplankton were primarily nauplii of the A. tonsa. The lack of larger sized mesozooplankton associated with the CMAX appears to be related to large abundances of the ctenophore Mnemiopsis leidyi that heavily graze large mesozooplankton in lower salinity waters. These results suggest a diminished grazing role for larger sized mesozooplankton on phytoplankton within the CMAX of the NRE. This result was further confirmed by associated grazing experiments.

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BEACH ENVIRONMENTAL QUALITY AND ITS MANAGEMENT: EVALUATING USERS BEHAVIORS, ATTITUDES AND PERCEPTIONS

This talk will discuss findings from a recent survey conducted in Santa Barbara County and Ventura County. This survey was designed to test the relationships between a users beach choice, activities, and perceptions and attitudes of environmental quality and its management. Detailed information on beach users can assist in crafting management policies that can help to sustain the benefits these ecosystems provide. There is a growing body of knowledge of coastal user activity and expenditure patterns. Yet there is little information linking the behavior of coastal users to their perceptions and attitudes of beach environmental quality and its management. Because environmental perceptions (of both managers and users) and reality are not always in agreement, testing such relationships is a crucial step in managing these resources. While sandy beaches are highly valued by society for their economic and cultural importance, their ecological features are often underappreciated. This is reflected in traditional management frameworks that promote maintaining and restoring physical and geomorphological features that support coastal defense and human recreation with little regard of ecological properties and processes. Our data calls into question this traditional management paradigm. A majority of beach users from our survey participate in ecologically dependent activities like viewing shorebirds and deem these opportunities important to their beachgoing experience. Further, most beach users feel an obligation to protect and restore these environments, and indicate a willingness to pay for such efforts. While most beach users are not very familiar with the ecology of beaches, many users indicated a preference for more access to this type of information. These findings, among others, provide important insight for evaluating beach management practices (e.g., raking) in a way that explicitly captures physical, biological, and socio-economic tradeoffs.

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MONITORING INSHORE SEAGRASSES OF THE GREAT BARRIER REEF: RESISTANCE AND RECOVERY IN RESPONSE TO WATER QUALITY AND EXTREME WEATHER EVENTS

Seagrasses of Australia's Great Barrier Reef (GBR) are recognised as key matters of national environmental significance because they provide food for endangered and threatened species as well as important provisioning and regulating services. A key role of the GBR Marine Park is to support healthy and resilient ecosystems, including seagrass habitats. As seagrasses are sensitive to environmental change, monitoring their status is critical in tracking human influences on coastal ecosystems and providing up-to-date information for management. The inshore tropical seagrass ecosystems of the GBR are being monitored as part of the Reef Rescue Marine Monitoring Programme (MMP) across the length of the GBR (>2000 km of coastline). Trends in seagrass status contribute to an assessment of the long-term effectiveness of management actions aimed at reversing declines in water quality of inputs entering the GBR Marine Park. Inshore seagrasses are currently monitored at 45 sites including measures associated with resistance (e.g. species composition, changing abundance) and recovery (e.g. reproductive effort, seed banks). Complementary data sets include tissue nutrients, light, and temperature. Monitoring results are used annually to report seagrass status and are incorporated into a report card for the health of the GBR. Trends since 2005, when the program began, demonstrate degraded water quality where plants were growing in low light environments, with a relatively large phosphorus pool and an excessive nitrogen pool. The poor status of seagrasses was further exacerbated by the extreme weather events across the GBR in 2011, resulting in widespread losses. There were significant flow-on effects of these declines to fauna dependent on seagrasses, in particular widespread death of dugongs. We will discuss the current status of seagrass across the GBR and the level of recovery observed since the extreme weather events of 2011.

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THE EFFECTS OF SEA LEVEL RISE ON THE DECOMPOSING COMMUNITIES OF A RESTORED SOUTHERN CALIFORNIA SALT MARSH

Salt marshes are important coastal ecosystems that provide key ecological services including carbon fixation, nutrient cycling as well as providing habitat for a diverse set of organisms. Southern California wetlands have been greatly reduced in size by urbanization and future sea level rise will exacerbate these effects. Increased inundation will negatively impact key salt marsh functions. Decomposers, including invertebrates, fungi, and bacteria, are key functional groups that may be susceptible to increased inundation, reducing their ability to release sequestered carbon and nutrients back into the ecosystem. To test how the decomposer community might be affected by SLR, we deployed a marsh organ (a structure that simulates sea level rise) in February 2013 containing native Spartina foliosa and sediments. The structure holds 3 rows of 6 PVC pipes at different tidal elevations with the highest row receiving natural inundation and the two lower rows receiving increased inundation consistent with future sea level projections. Traditional invertebrate taxonomic classification, plant photosynthetic rate measurements, molecular microbial community fingerprinting techniques, and 454 pyrotag sequencing have been used to monitor the

impacts of increased inundation on salt marsh decomposer community structure. Impacts on decomposition activity are being assessed via litterbag experiments and sulfate reduction rate (anaerobic respiration) assays every three months for the 1 year deployment. Preliminary findings indicate that active, diverse communities of all three groups were present in marsh sediments at the start of the experiment. Pyrotag sequencing data has indicated a response of the microbial community to treatment effects. The data from this study will assist wetland management and restoration efforts to protect wetlands from impacts of sea level rise.

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SHOULD NUTRIENTS OR BIOLOGICAL RESPONSE BE THE BASIS FOR REGULATING EFFECTS OF EUTROPHICATION? THOUGHTS BASED ON WORK IN SOUTHERN CALIFORNIA BIGHT ESTUARIES

Among scientists working on nutrient numeric criteria development, the question of whether to establish criteria based on ecological response indicators or nutrient concentrations and/or loads is an area of active debate. In California, efforts to establish numeric nutrient criteria have been hampered by the lack of data for most of the State's estuaries. In this study, we utilized a one-year data set collected synoptically in 23 Southern California estuaries to investigate empirical nutrient-response relationships. We used multiple regression models to examine the relationship between primary producer biomass and dissolved oxygen (DO) concentrations as dependent variables and nutrient loads, estuarine surface water nutrient concentrations, sediment organic matter content, and hydraulic residence time as independent variables. Macroalgal and phytoplankton biomass were both significantly correlated with riverine nutrient loads as well as estuarine nutrient concentrations, but the model fit was poor ($R2 < 0.3$). DO had no significant relationship with nutrient loads or estuarine nutrient concentrations. Annually averaged macroalgal biomass was best predicted by a stepwise linear regression model that included annual TN loads, sediment organic matter, and hydraulic residence time ($R2 = 0.58$). However, hydraulic residence time and sediment organic matter accounted for 55% of the variability while annual nutrient loads only accounted for ~5%. The best model fit for the 10th percentile of DO included sediment organic matter content and hydraulic residence time ($R2 = 0.31$). Thus, statistical analysis of empirical nutrient-response data to derive regional nutrient criteria may not be practicable in southern California estuaries because site-specific factors override simple nutrient limitation of primary production. Near term steps include development of site-specific mechanistic models that account for environmental factors that control ecological response.

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SHORELINE STABILIZATION UNDER SHIFTING SEAS: URBANIZATION TRENDS AND UPLAND CONNECTIVITY IN SALT MARSH ECOSYSTEMS

Shorelines throughout the world are armored with engineered structures to protect property from an encroaching sea. In salt marshes, stabilization controls such as bulkheads are often installed at the upland border as a defense against coastal erosion. These features may interrupt hydrological and ecological connectivity at the land-sea interface, resulting in alterations in the structure and function of salt marsh ecosystems. In this study, we used geographic information systems to investigate the spatial distribution of armored structures in the state of Georgia with respect to land use and land cover. We found that upland immediately adjacent to hardened shorelines was highly developed at the parcel scale, and the extent of armoring was tightly linked with indicators of urbanization at the county scale (impervious surface coverage; $r = 0.98$). We also conducted field surveys to elucidate ecological linkages between the high marsh and adjoining upland cover. The study employed a block design that included residential sites both with and without bulkhead structures, in comparison to unmanaged forested areas that served as reference sites. A suite of variables, including porewater nutrient concentrations and microbial community composition in marsh soils, are currently being analyzed to assess patterns and processes associated with the selected upland classes. Hardening of the shoreline interferes with the capacity of intertidal zones to migrate landward in response to sea-level rise, and as such, it is important to characterize the potential loss of marsh ecosystem services within the context of climate change.

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APPLIED VISUALIZATION FOR HURRICANE STORM SURGE RISK AWARENESS AND EMERGENCY MANAGEMENT

While storm tracks, intensity forecasts, and tabular metrics have become ubiquitous, they do little to convey the highly localized effects of potential flooding at municipal or facility scales. Visualizations of storm surge forecasts offer opportunities to improve risk awareness and communication in emergency situations. Enhanced visualizations that better communicate "on the ground" potential flooding impacts play an increasingly critical role in risk communication and emergency response. Recent storm surge modeling efforts in Florida, North Carolina, and Virginia will be discussed for their contributions to enhanced risk communication and provision of diverse forms of storm surge geovisualization. In these case studies, GIS and cartographic techniques combine surge forecasts, orthophotography, and building planimetrics for determination of critical infrastructure accessibility, economic losses, and identification of social vulnerabilities. Such applications require cautious and informed use of disparate data (meteorological, geospatial, infrastructural). Awareness of surge model limitations, factors inhibiting spatial representation, and technical and communications challenges is required.

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IT TAKES TWO TO TANGO: FOSTERING TWO-WAY ENGAGEMENT BETWEEN SCIENTISTS AND POLICYMAKERS

Scientists who want to make their science matter, particularly in a policy context, often do not know where or how to find opportunities to do so. Being effective in what can seem like a foreign culture requires the equivalent of local knowledge: keen insight into what is on a policymaker's mind at a given moment, the decisions they face in the future, and the broader context for those decisions. COMPASS invests in tracking decision-making landscapes, on both the executive and legislative fronts, to identify opportunities for science to enrich the policy dialogue. In this talk, we will share insights from connections we've brokered between scientists and federal policymakers on topics spanning ecosystem-based management, large-scale estuarine restoration, and ecosystem services. The most productive of these connections have developed into ongoing, two-way interactions. This type of sustained dialogue sparks new – and highly relevant – directions for the science, better understanding by the science community of how to share their insights, and deeper appreciation by the policy community of the challenges and opportunities in front of them. The relationships built through this kind of engagement lay important foundations of trust and access that break down the barriers that so often exist between these two communities. Such relationships are crucial to bridging the science-policy gap, ultimately paving the way for policies informed by relevant science.

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WIND-DRIVEN VARIATIONS IN NEAR-BOTTOM DISSOLVED OXYGEN OVER THE CENTRAL CALIFORNIA CONTINENTAL SHELF

A moored autonomous profiler was deployed at the 70-m isobath over the shelf near Monterey, California to collect hourly profiles of oxygen concentration between the surface and 60 m depth. Sampling was conducted over two seasons: one 2-week deployment during spring upwelling and two 4-week deployments during the fall transition. Few such high resolution and deep, near-bottom measurements of oxygen are available for the central California continental shelf. These data provide valuable insight into the dynamics of offshore source water, supplementing many years of observations of the pulses of low dissolved oxygen water on the region's inner shelf. During the spring upwelling season, relatively low oxygen waters consistently filled the deep portion of the shelf, with concentrations below potentially harmful threshold levels (~ 4.6 mg L-1, 2.9 ml L-1) persisting for ~7 days and extending upward as far as 20 m depth. During the fall deployments, wind reversals and adjustments between upwelling and downwelling were common over the shelf and low-oxygen conditions were more episodic. Distinct pulses of dense water onto the shelf brought sub-threshold oxygen levels to depths of 40 to 50 m on four separate occasions, each persisting approximately 4 to 6 days. Although low oxygen concentrations were observed during both seasons, in no case did we observe hypoxic levels, which is consistent with previous studies finding generally higher oxygen on the shelves of Central California compared to those in the northern part of the eastern boundary current. The height to which low-oxygen water extended was strongly related to isopycnal movement, which varied on upwelling/relaxation time scales (4 to 6 days) as well as at semidiurnal and diurnal time scales

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PHYTOPLANKTON RESPONSES TO GLOBAL CHANGE

Unprecedented basin-scale changes are occurring in our seas. Climate change is resulting in warming temperatures, declining ocean pH, decreasing sea ice, shifts in biological communities, and alterations to marine physical regimes. At the base of the marine food-web, phytoplankton are tightly linked to their environment and offer insight into pelagic responses to change in the marine system. Understanding of open sea phytoplankton dynamics is crucial for interpreting coastal observations and aiding the separation of responses to climate from those driven by anthropogenic pressures. Much of our knowledge of macroecological change in the pelagic North Atlantic results from analysis of data gathered by the Continuous Plankton Recorder (CPR) survey, a near-surface plankton monitoring programme which has been towing in the North Sea and North-East Atlantic since 1931. The CPR survey, coordinated by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), uses ships of opportunity to routinely sample ~500 plankton taxa on a monthly basis. Indicators developed using CPR data have revealed novel information about: shifts in primary production; changes in harmful algal bloom dynamics; alterations to phytoplankton community composition and diversity; phenological changes; biogeographical range shifts; ocean acidification responses; introductions of non-native species; and changes in biodiversity. These alterations in open sea phytoplankton communities offer insights which aid in the interpretation of changes in coastal plankton dynamics.

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A RESEARCH AGENDA TO SUPPORT CARBON CREDIT ACCOUNTING IN TIDAL WETLANDS

The concept of granting carbon credits for activities that ultimately reduce atmospheric concentrations of greenhouse gases has recently been extended to encompass so-called Blue Carbon ecosystems such as tidal marshes and mangroves. The first generation of methodologies for implementing tidal wetland carbon trading projects has been possible because estuarine research scientists have studied the details of carbon cycling in these ecosystems for decades. However, significant knowledge gaps remain that must be filled in order to fund wetland restoration and other activities by capitalizing on volunteer and regulatory carbon credit markets. Difficulties arise from the need to account for carbon dynamics at a landscape level. For example, it is necessary to quantify the amount of soil carbon sequestered from allocthonous sources and determine the fate of this material in the absence of the wetland project. We offer one approach to address this issue based on evidence that the recalcitrant fraction of allocthonous carbon is associated with mineral surfaces. A second issue is the fate of soil organic carbon when a tidal system converts to open water. In this case, credit for intervening to prevent inundation can be granted only if carbon is returned to the atmosphere. Finally, it remains challenging to quantify emission of methane and nitrous oxide from tidal wetlands because these compounds do not form pools that can be easily measured. Research from the estuarine community is needed on these issues before the potential of carbon credit systems to benefit wetland restoration is fully realized.

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MEASURING CHANGES IN TOTAL PHYTOPLANKTON-SIZED PARTICLE VOLUME OVER TIME AS A PROXY FOR PRIMARY PRODUCTION IN NARRAGANSETT BAY, RI

Changes in total phytoplankton biovolume over time can be used as a proxy for cell growth due to photosynthesis. This approach was evaluated by measuring the total volume change in phytoplankton-sized particles during 5-hour incubations under simulated sunlight. Surface samples were collected from Narragansett Bay, RI on six dates between June and August of 2012 at five stations spanning Narragansett Bay's chlorophyll and nutrient gradients. Total particle volume was measured using a Sequoia Scientific LISST 100-X Laser In Situ Scattering Transmissometer over 32 logarithmically distributed size bins between 2.5 and 500 μm. This size range covers both photosynthetic nano and microplankton species. Concurrent measurements of chlorophyll, carbon-14 uptake, and microscopic enumeration and identification of taxa were conducted. An apparent increase in the volume of phytoplankton-sized particles was detected during the incubations for the majority of samples. The potential advantage of this approach is that it provides a relatively non-destructive method to repeatedly sample size-fractionated phytoplankton growth over time. However, there are significant challenges with minimizing sampling noise, and the instrument's inability to distinguish phytoplankton from other living and non-living particles in the water.

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IMPACTS OF COASTAL SPRING DISCHARGE ON A SHALLOW MARINE ESTUARY

Coastal areas around the world have undergone unprecedented population growth in the last few decades and thus are susceptible to sea level change and decreasing water quantity and quality. The relationship between surface and subsurface estuarine hydrologic processes in coastal regions has not been investigated fully, and existing hydrologic models cannot easily integrate the inputs and outputs that occur through subsurface conduits that discharge into a myriad of coastal estuarine springs and seeps. In Florida there are over 1100 known springs compared to 150 surface rivers. Double Keyhole Spring is a brackish water system that is an example of a coastal spring that is influenced by both the Floridan aquifer and the surface estuary. Using ADV data we estimated water flows through the system varies with tidal cycle and seasonal rainfall from -1449 L/sec at high tide prior to TS Debby to 2577 L/sec at low tide after TS Debby. Average discharge for the 8 months prior to TS Debby was 648 L/s, and was 1171 L/s for the 7 months after TS Debby. This flow rate is approximately one-tenth that of the Hillsborough River and demonstrates the important role coastal springs play in the interface of the Floridan aquifer and the Gulf of Mexico. Preliminary work on Double Keyhole Spring and surrounding surface sites includes mapping the spring, establishment of sampling locations, deployment of datasondes to monitor water velocity and physical water parameters, and the collection of water samples for chemical water parameters and microbial community analyses. Microbial community structure and water chemistry data from Double Keyhole Spring and the surrounding estuary indicate spatial and temporal differences between sites. Long term monitoring of Double Keyhole Spring and the surrounding estuary is necessary to show changes in water chemistry and community structure with the primary goal of determining the impacts Double Keyhole Spring discharge has on the surrounding estuary.

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QUANTIFYING METHANE GAS FLUXES IN RELATION TO INVADING PHRAGMITES AUSTRALIS IN TIDAL BRACKISH MARSHES IN A TRIBUTARY OF THE CHESAPEAKE BAY

Tidal marshes are highly productive ecosystems with the potential to sequester large amounts of carbon dioxide and emit greenhouse gases (GHGs) such as methane (CH4), which they emit at rates that may offset the carbon sink function of tidal wetlands. The carbon sink function is relatively well quantified in salt and brackish wetlands, but there is relatively little known about CH4 emissions from these ecosystems. In particular, it is unclear how species shifts may change the radiative forcing of a wetland. An introduced lineage of the common reed, Phragmites australis, is rapidly invading North American tidal wetlands. As plant communities shift it is important to understand how these species shifts may change the ecosystem carbon balance. We quantified rates of CH4 emissions between introduced Phragmites australis and native plant communities (Spartina patens, Distichlis spicata and Schoenoplectus americanus) in a brackish Chesapeake Bay tidal marsh using static flux chambers along four transects between the two communities. Both clear and opaque chambers were used to control light versus dark conditions. Methane Emissions were measured in the native community, P. australis community and a transition zone containing both native and introduced plant communities over a period of two hours. Diffusive CH4 emissions were significantly greater in the Phragmites-dominated communities than native communities. Assuming that CH4 emissions via ebullition are negligible or unchanged by Phragmites, the result suggests that this invasive species can increase methane emissions and has the potential to change the radiative forcing of a tidal wetland.

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INVESTIGATION OF THE MORPHODYNAMICS IN THE LOWER MISSISSIPPI RIVER IN THE VICINITY OF BONNET CARRE SPILLWAY DURING AND AFTER THE 2011 FLOOD

The operation of the Bonnet Carre spillway during the flood event of 2011 (diverted 10 - 20% of the flow for 56 days, from May 1st to June 25th) is considered analogous to large pulsed diversions. It provides an opportunity to observe the hydrodynamics in the vicinity of a large diversion and the morphological response of the main river to such diversion. In this study, a three-dimensional model was setup using Delft3d model. The model was calibrated and validated through detailed field observations gathered during the 2011 flood and subsequently in 2012, and 2013. The field data included detailed multi-beam mapping of the river bottom in May and June 2011 (immediately before and after the flood event). These successive maps were used to quantify the bed level changes. Detailed measurements of velocity, suspended load, bed load, as well as bottom grab samples were used to calibrate and validate the Delft3D model. The model showed reduction in stream power in the river due to the pulsed diversion leading to a rapid aggradation of sandy (non-cohesive) material in front of the structure. Subsequently, the model and the field data showed that the material initially deposited in front of the spillway was largely eroded and migrating downstream. The sediment budget based on the model results was calculated for 45-day event during May-June 2011. The total sand load in the River cross section upstream of the spillway was used as a reference quantity. Based on the sediment budget, 48 % (~ 12 million metric tons) of total sand transported by the Mississippi channel upstream of the diversion was deposited on the riverbed in the reach immediately in-front, and downstream of, of the spillway; while only 3% of sand was diverted into the spillway.

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SCIENCE INTEGRATION: DEVELOPING TOOLS, APPROACHES, INSTITUTIONS AND CAREERS FOR CONNECTING KNOWLEDGE WITH ACTION

Science integration is fundamentally about tackling the challenge of connecting knowledge with action. Making these connections takes active effort, working across boundaries, honoring and translating knowledge from multiple domains. This is an institutional, political, intellectual, communications, and even cultural challenge. In this talk I will describe the challenge of science integration through a discussion of old and new “myths” that pervade our science and policy system. These are ideas about what is needed to make science more effective in supporting problem solving, such as interdisciplinarity, participatory research, and an emphasis on funding for basic research as opposed to applied. I refer to these ideas as “myths,” not because they are all untrue, but because they are often embraced without critical thought about what they are, and how and when they might be useful. Having outlined that challenge, I will then talk about the tools, institutions, and skills needed for effective science integration, focusing in particular on some of the approaches that the California Ocean Science Trust is using as we endeavor to craft a constructive role for science in decision making.

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CAN YOU MANAGE SUSQUEHANNA RIVER SEDIMENTS STORED BEHIND THE CONOWINGO DAM AND THEIR IMPACTS TO THE CHESAPEAKE BAY?

The Susquehanna River provides up to 47% of the fresh water, 41% of the nitrogen, 25% of the phosphorus and 27% of the sediment to the Chesapeake Bay. The Conowingo Dam has been trapping sediments from the Susquehanna River since its completion in 1928. It is estimated that 3 million tons of sediment are transported down the Susquehanna with 2 million tons trapped behind the Dam each year. During high flow events, legacy sediment and nutrients are scoured from behind the Dam and deposited in the Chesapeake Bay, negatively impacting water quality, habitat and living resources. It is estimated that heavy rains over the Susquehanna River watershed from Tropical Storm Lee in September 2011 scoured 4 million tons of sediment from behind the Dam, delivering a sediment and nutrient laden plume that persisted several months. Maryland State agencies along with other federal and local stakeholders are evaluating the complexity of these high flow events, their timing, magnitude and sediment management strategies as a means to help protect and restore the Chesapeake Bay.

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WINNERS AND LOSERS: ECOLOGICAL AND FISHERIES IMPACTS OF COASTAL HYPOXIA OFF BAJA CALIFORNIA, MEXICO

Hypoxia is an escalating threat in the world’s coastal waters, with potentially severe consequences for marine life and ocean economies. In addition to global and regional trends of decreasing dissolved oxygen (DO), hypoxic events in shallow nearshore locations are of special concern because they potentially impact coastal species that support important economic sectors, including fisheries. Hypoxia is not limited to estuaries and embayments, but also affects open coastal systems. Recent occurrence of hypoxia in coastal Baja California, Mexico, and accompanying mass mortalities of benthic organisms and impacts on coastal fisheries, has raised concern about the ecological and economic effects of hypoxia in these open coastal systems. Combined oceanographic and ecological monitoring conducted and evaluation of risk posed by hypoxia to different species indicate that kelp-associated species and coastal fisheries of Baja California are differentially affected by hypoxic events. Biophysical monitoring and risk-based approaches can inform fisheries management by identifying winners and losers in the face of hypoxia.

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MARINE PROTECTED AREA PROGRAM EFFECTIVENESS: THE USE OF PERFORMANCE MEASUREMENT IN NOAA’S NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM (NERRS)

NOAA’s National Estuarine Research Reserve System (NERRS) is a network of 28 estuary reserves across the United States dedicated to addressing coastal management needs through long-term research, education and stewardship. The NERRS system of performance metrics is used to assess how effective the NERRS are in working toward its mission of practicing and promoting the stewardship of coasts and estuaries through innovative research, education and training using a place-based system of protected areas. Performance metrics are aligned to a five-year strategic plan that addresses three priority areas: climate change, habitat protection, and water quality. Through a combination of output and outcome measures, the NERRS can demonstrate and evaluate its contribution to Marine Protected Area (MPA) network management and coastal management in general. Discussion includes how NERRS programs enhance the protection and management of coastal and estuarine resources through the use of place-based approaches at a national system of MPAs, improve the understanding of and inform decisions affecting estuaries and coastal watershed through scientific investigation, and increase environmental literacy and the ability to make science-based decisions in various targeted audience (public audience, coastal decision makers, and educators and students).

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SPATIAL AND TEMPORAL VARIATION IN AQUATIC PLANT AND INVERTEBRATE COMMUNITIES IN SUISUN BAY AND THE SACRAMENTO-SAN JOAQUIN DELTA, CA

Having recently discovered 1100 acres of native Stuckenia spp. (pondweeds) in the Sacramento-San Joaquin Delta and Suisun Bay (San Francisco Estuary), we conducted a survey to document patterns in plant and invertebrate assemblages at 8 sites along a salinity gradient from brackish to fresh. We collected quarterly samples for 1 year of all plants and macro and epiphytic algae present and extracted, identified, and counted all invertebrate species from these samples. We found the fresher sites were dominated by the non-native plant Egeria densa in spring and summer, with a marked transition to high species-diversity by late summer/fall, compared to the brackish sites being mostly Stuckenia-dominated. We also found a wide range of spatial and seasonal variation in invertebrate species composition and abundance. We observed a large decline in abundance of all invertebrate species during winter in Suisun Bay, coinciding with the senescence of aquatic vegetation. Additionally, summer collections indicated dominance of gastropod species, and fall collections showed the greatest abundance and diversity of both invertebrate and plant species. We also observed consistent spatial differences in invertebrate species composition, relating to the salinity gradient of our 8 sites from the fresh Delta to the saltier Suisun Bay. The most central site, of intermediate salinity (Sherman Lake), hosts a mixture of the species residing in nearby sites. These results indicate a relationship between salinities, season and both

abundance and species composition of invertebrate species inhabiting submerged vegetation in the Delta and Suisun Bay. These findings may help predict subsequent invertebrate community diversity shifts and changes in abundance with foreseen climatic changes including increased salinity associated with sea level rise. The findings may also elucidate seasonal and spatial food source fluctuations for CA fish species of concern thought to feed on these invertebrates.

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FISHSMART: A STAKEHOLDER-CENTERED MODELING APPROACH TO IMPROVE FISHERIES CONSERVATION AND MANAGEMENT

Fisheries management often limits an effective and meaningful exchange of information and ideas between stakeholders and managers. Our objective was to develop a process that allows stakeholders to develop recommendations to improve the fishery through voluntary measures and provide management recommendations that they supported. We developed a "stakeholder-centered" process that facilitated explicit goal setting and iterative evaluation of options acceptable to stakeholders. An initial application involved angler, tournament, commercial, management, recreational industry, and conservation stakeholders for the southeastern U.S. king mackerel (Scomberomorus cavalla) fishery. The stakeholder workgroup developed objectives for the fishery, options that could be used to achieve the objectives, and performance measures to gauge whether objectives were reached. Objectives included traditional and non-traditional goals such as maintaining high and stable catches and retaining the opportunity to catch large fish, and options included voluntary changes in fishing practices and mandatory regulations. Stakeholders were an integral component in developing a model to allow them to compare how well their options met their objectives. Based on the results of the decision analysis, stakeholders developed a consensus suite of recommendations, including more conservative length and bag limits than those initially recommended by management. The immersion of stakeholders in reviewing the available science and developing the model led to recognition that more conservative management was necessary to achieve their objectives. This project demonstrated that stakeholders can be included in a meaningful participatory process that can improve fisheries management, but inclusion requires increased time and an effort to provide science without jargon or condescension.

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MONITORING ACIDIFICATION AND CARBONATE CHEMISTRY DYNAMICS AT ECOLOGICALLY RELEVANT SCALES IN CHESAPEAKE BAY AND NEAR-SHORE ECOSYSTEMS

Because of their relative shallowness and reduced salinity and alkalinity, coastal marine habitats and estuaries are typically less buffered to changes in pH than is the open ocean. This makes coastal systems more prone to CO2-induced changes in pH. Coastal systems also have much more complex carbon cycles than the open ocean, which maintains a nearly constant air:sea equilibrium in surface waters. In near-shore waters, ecosystem metabolism (e.g., benthic respiration and photosynthesis) strongly influences day:night and seasonal carbonate chemistry dynamics, while tidal/circulation patterns are important drivers of land:sea interactions that affect chemistry at local scales. Our group has developed instrumentation that enables real-time measurements and logging of pCO2. Working in the Chesapeake Bay, we have documented carbonate chemistry dynamics intensively during the past 1½ years and see striking patterns of temporal and spatial variability in pCO2. Despite their natural variability in pH and pCO2, increases in atmospheric CO2 may well generate a shifting ecological baseline, much more complex than is expected in the open ocean.
To date, few studies have focused on measuring and understanding the complex nature of carbonate chemistry dynamics in coastal systems, especially at spatial and temporal scales that are ecologically relevant to the biota that inhabit such locations. We believe that such investigations are important not only for understanding the process of coastal acidification, but also for providing insight to habitat and fisheries restoration/management and for characterizing potential effects of coastal acidificaton on future aquaculture efforts.

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LINEAR-REFERENCED COASTAL GEOMORPHOLOGY IN THE US GEOLOGICAL SURVEY NATIONAL HYDROGRAPHY DATASET

The Coastline feature in the U.S. Geological Survey's National Hydrography Dataset has been enhanced to include landforms and the correlative risk of landform change. This is accomplished through linear referencing where information or attributes can be added to a vector feature without changing the underlying data structure. In this case, landform change attribution is from the Department of Energy's Coastal Hazards Data Base serving as an authoritative source. Along the West Coast, we identify landforms that transition from deep-marine types forming the shore of the Strait of Juan de Fuca, to lagoons, cliffs, and estuaries including the Tijuana Estuary on the international border with Mexico. The Atlantic Ocean shoreline trends from glaciated terrain estuaries in Maine to non-glaciated estuaries and extensive barrier complexes south of New England. The Gulf of Mexico (GOM) coastline transitions from the Padre Island, Texas barrier complex to the Mississippi River Delta, and then to biogenic landforms along the Florida panhandle; estuarine environments between these systems comprise roughly fifty percent of the coast. Results for landform type total length estimates indicate estuaries are prevalent along all coastlines. Estuaries without vegetative cover that are more common along the northern West Coast and southeast Florida coast are ranked with a high to very high risk of change, as are delta, beach, and barrier landforms. Estuarine salt marshes common along much of the East Coast and GOM are ranked with a moderate risk. Location and distribution of estuaries, other coastal landforms, and the associated risk ranking provide spatial-temporal data significant for analyses and modeling coastal zone systems and changes important to managing and protecting ecological systems and communities. The geodata identifying relatively stable to transitional coastlines may also help prioritize mapping revisions at the USGS by steering resources to more vulnerable coastlines.

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DELIVERING PROFESSIONAL DEVELOPMENT IN A FISCALLY CONSTRAINED ENVIRONMENT

Current research budgets and education programs are fostering an increasing number of interns, undergraduates and graduate students working in research laboratories. As such, effective mentoring is key to developing and retaining these individuals in the STEM workforce. To meet this need, CERF's Education Committee has proposed a series of professional development webinars. The first webinar, *Effective Strategies for Mentoring*, took place in April 2013. Dr. Tim Dellpenna, from Texas A&M University, led a 1.5 hr presentation and discussion using the Webex platform. Registration and post-webinar assessments were conducted online through the CERF website and using Survey Monkey, respectively. Twenty-three groups / unique IP addresses from 11 institutions participated, with several institutions hosting group participation. Most participants were graduate students and all but 2 had previous mentoring experiences. The majority of groups (18) felt the webinar was a valuable use of their time and most (15) felt that it improved their ability to mentor. Many participants stressed the value of the case study approach. When asked what they would now incorporate into their mentoring style, most participants stressed clear communication and clearly defined expectations. Participants felt that communication was the most important aspect to an effective mentoring relationship. The Webex platform was a successful mode for delivery: no one found it difficult to use, few had technical issues and cost was relatively low. Surveys indicated no one felt the virtual nature of the presentation and discussion impeded their learning, although several mentioned the inability of relaying all of the conversations taking place at each location through this platform during the limited discussion period. When asked for suggestions of additional webinar topics, replies were numerous, perhaps reflecting the success of this approach for professional development.

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IMPORTANCE OF COPEPOD GRAZING ON *HETEROCAPSA ROTUNDATA* IN WINTER BLOOMS

Winter dinoflagellate blooms in Chesapeake Bay tributaries can account for over 50% of their annual primary production, more than the spring diatom bloom. What happens to this new production, does it move up the food web through grazing or become recycled in the microbial loop? We conducted microzooplankton grazing (dilution), copepod grazing, and primary production experiments once a week from December 23rd, 2012 – March 10th, 2013 with water collected from the Choptank River. We examined microzooplankton and copepod grazing on the total phytoplankton community and on specific phytoplankton species and copepod grazing on various microzooplankton. There was not a pronounced winter bloom in 2013 but there was evidence of a trophic cascade affecting the

dinoflagellate, Heterocapsa rotundata, from grazing by microzooplankton and the copepod, Eurytemora carolleeae. There was no significant difference in the magnitude of copepod and microzooplankton community grazing, but copepods did selectively graze on H. rotundata over other phytoplankton species. This implies that H. rotundata dominated winter blooms can enhance new primary production movement up the food web and could contribute to production at higher trophic levels.

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WILL CLIMATE CHANGE INFLUENCE THE RECRUITMENT OF MANGROVES?

A key to predicting distributional shifts and range limit extensions of mangroves is to determine how alterations to the coastal environment under climate change influences recruitment processes, particularly propagule dispersal and seedling establishment. We will present research outcomes from experiments designed to examine how variations in ocean temperature and salinity under climate change might influence the recruitment of *Avicennia marina* in temperate Australia. We manipulated water temperature (15 to 25 degrees) and salinity (0 to 35 ppt) in environmental chambers and then quantified buoyancy times for mature propagules of varying size (3 to 10 g). Dispersal potential was strongly related to propagule size, temperature and salinity. On average propagule buoyancy was inversely related to proagule size. Across all sizes, propagules floated longest in cool saline water and sunk most rapidly in warm fresh water, with a threefold difference in flotation time. To determine whether dispersal conditions influenced the establishment and early growth of seedlings, propagules that sunk were individually planted in a common garden and maintained under identical environmental conditions. Under all dispersal conditions establishment and early growth of seedlings were positively related to propagule size. Variations in ocean temperature and salinity during dispersal also influenced establishment success, and on average seedlings grew larger at higher water temperatures and salinities. Consequently, if temperate Australian waters become warmer and fresher, then propagule dispersal of *Avicennia marina* should become increasingly localized, potentially reducing connectivity among isolated mangrove populations. Nevertheless, propagules of *Avicennia marina* are capable of long distance dispersal and those that disperse to new locations under such oceanic conditions should have a high probability of establishment success.

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USING ORGANIC MOLECULES AS A HOOK TO REEL IN UNDERGRADUATE LANDLUBBERS

An undergraduate course entitled Environmental Forensics was created and taught to geological science majors at East Carolina University, Greenville, North Carolina. The City of Greenville has a historically unsolved environmental contamination case involving hydrocarbon pollution. The local contaminated site was the focal point around for the students throughout the semester. Students acquired practical laboratory skills by conducting organic chemical extractions. After initial practice extractions were conducted on coastal sediment cores, students applied knowledge they had learned to samples collected from the local site. Undergraduate students generally find it challenging to establish a link with the local community surrounding their educational institutions. However, learning about the legacy and history of the local community was critical for the students in order to comprehensively investigate the locally-polluted site. In addition to field and lab work, and a few brief lectures, the course featured guest speakers from the city of Greenville, the N.C. Department of Environmental and Natural Resources, an environmental hydrogeologist, and an environmental lawyer. So, students also learned about various employment opportunities in their profession. The novelty of this course was that it used several pedagogical approaches simultaneously: didactic, experiential, and service-oriented learning all of which when taken together resulted in tangible benefits to the students and the local community. During this presentation, I will discuss the application of this approach to promoting coastal and estuarine research and education.

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THE HOLOCENE BURIAL FLUX OF REFRACTORY CARBON IN MID-ATLANTIC ESTUARINE AND MARSH SEDIMENTS

Organic carbon, mainly produced via photosynthetis is lost or "mineralized" within the land-ocean interface during transport to the oceans. However, a small residual portion of organic carbon is preserved in the sediments. This residual, presumably refractory, amount is extremely important as it determines the balance between CO2 and O2 in the atmosphere over time and ultimately regulates climate. In this study, we will present estimates for the burial flux of refractory carbon in sediment cores from four locations in the mid-Atlantic coast of the United States. Sediment cores representative of the late Holocene epoch were collected from two estuaries: the Chesapeake Bay and the Albemarle-Pamlico Estuarine System; these cores represent both subtidal and salt marsh settings. Refractory carbon comprises ~5 to 45% of the total organic carbon in sediments at all the sites and hence represents a substantial portion of the total organic carbon buried across these coastal systems. The deposition flux of refractory carbon in these samples appears to be periodically modulated by the position of the Gulf Stream, suggesting that throughout the Holocene, a positive feedback loop may have existed between coastal carbon sequestration and mid-Atlantic climate.

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HORSESHOE CRAB *TACHYPLEUS GIGAS* IN THE EAST COAST OF PENINSULAR MALAYSIA: SIMPLE WHITE BUTTON TAGGING AND DETERMINATION OF POPULATION SIZE

Recently, horseshoe crabs are gaining popularity as new exotic delicacies in Malaysia especially in Johore. Export to Thailand has been reported, and some fishermen claims that the horseshoe crabs were transported in bulk especially the females. This claim has sparked the interest to identify the population and their behavior in the east coast of Peninsular Malaysia as an attempt to determine the effect on the existing population. A study was carried out from December 2011 to March 2012 to determine the horseshoe crab Tachypleus gigas population size in Chendor and Cherating, Pahang in the east coast using a standard Capture-Mark-Recapture method. The sampling was carried out four times in both areas. The population size was calculated using Triple Bailey's formula with the assumption of an open population. The horseshoe crabs 'travelling distance' was also determined using a simple white button tags that bears the phone number of the researcher. A total of 99 individuals were tagged (61 in Chendor, 38 in Cherating). The total estimated populations were 7140 in Chendor and 9111 in Cherating. The two populations were found to be interchangeable as the tagged animals from Chendor were recaptured in Cherating and vice versa, thus confirming emigration and immigration. About 25% of tagged animals were recovered in various places as reported by fishermen. Interestingly, animals tagged in Cherating were caught in a few locations in Pahang including Tanjung Lumpur which is more than 50km to the south. This study is still on-going and calls are still expected from catchers regarding the location of the tagged animals.

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FISH OTOLITHS AS INTRINSIC GEOCHEMICAL PROXIES OF HYPOXIA EXPOSURE IN THE NORTHERN GULF OF MEXICO

The population-wide sublethal effects of hypoxia on fish species are difficult to assess without reliable biomarkers describing individual lifetime exposure histories. Here we examine fish otoliths, biogenic carbonates that deposit consecutive growth increments, as permanent chronological geochemical proxies of hypoxia exposure. Hypoxia alters bottom water chemistry due to reductive release of dissolved manganese as Mn^{2+} from the sediments, which may be incorporated into the otoliths of fish inhabiting hypoxic waters. To test this hypothesis, we examined the chemical composition of otoliths from demersal Atlantic croaker *Micropogonias undulatus*, collected on research cruises in the fall and summer in northern Gulf of Mexico. In October 2010, fish were collected from sites with varying dissolved oxygen levels (D.O. range 0.7 – 6.3 mg l^{-1}), but only fish from one site east of the Mississippi River showed strong seasonal otolith Mn:Ca signals. Record flooding

of the Mississippi River in 2011 resulted in a summer hypoxic zone of 17482 km^2, and both fish and bottom water samples were collected in October 2011 from the same stations as the 2010 cruise. Severe drought in 2012 resulted in a small summer hypoxic region of 7482 km^2, and bottom water samples collected in June and August of 2012 exhibited elevated dissolved Mn:Ca (range 30 – 388 $\mu mol\ mol^{-1}$) at sites with low D.O. (range 0.08 – 2 mg l^{-1}). Otoliths from the 2011 and 2012 cruises were also analyzed and examined for correlations between ambient dissolved Mn:Ca and otolith Mn:Ca in response to summer hypoxic regions of different sizes. Validating a permanent chemical marker in fish indicating duration and severity of hypoxic exposure, in combination with physiological biomarkers of reproductive impairment, would further enhance our understanding of population wide responses to hypoxia and the potential consequences for ecosystem functioning.

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THE SEASONAL, INTERANNUAL AND LONGER TERM VARIABILITY OF THE CIRCULATION OF PATOS LAGOON AND ASSOCIATED PROCESSES

Seasonal, interannual and longer term variability of the main factors tied with the circulation of Patos lagoon was evaluated through the analysis of historical and more recent data. Historical data consists of time series of wind velocity, river discharge and water level covering a period of at least 40 years. Salinity data obtained at the entrance channel area has been measured continuously since 1988. The analysis of historical data has shown that the seasonal variability of the water level and salinity is controlled by the combination of river and wind effects. Above average water level values are observed from May to October while for salinity this situation is observed from January to June. This is also confirmed through the analysis of more recent information. Interannual variability is mainly tied to river discharge and winds that also reflect the effects produced by El Niño (above average discharge, seaward flow favorable winds) and La Niña events (below average river discharge, landward flow favorable winds). The combination of these factors can alter the main behavior of this area producing a series of changes in the composition of the species, suspended sediment concentrations, light penetration, residence time, problems for rice crops along the margins, causing, also, socio-economic impacts. The longer term trend indicated that river discharge is increasing and so is water level in a rate of 2.5 mm/y. These two factors are probably tied, however, other possibilities are discussed. The main possible consequences with long term trends are also discussed.

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INTERNAL WAVES IN THE NEARSHORE COASTAL OCEAN

In this talk I will discuss the results of several studies carried out in the relatively shallow waters of inner shelves that show the presence and often dominance of internal waves. These internal waves can drive complex flows, provide shear that is important to dispersion and can break, resulting in substantial mixing. In particular, I will highlight our ongoing work on turbulence associated with wave breaking and internal wave shoaling, arguing that this "internal wave surf zone" is a central physical feature of nearshore ecosystems like coral reefs or kelp forests.

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IMPACTS OF DROUGHTS AND LOW FLOWS ON HEALTH AND PRODUCTIVITY IN THREE TEXAS LAGOONS

Texas estuaries are bar-built lagoons, some with continuous inflow, and some with intermittent inflow. All Texas lagoons are vulnerable to growing human water demands, climate change, and doughts. This study investigated the effects of historic droughts in three Texas lagoons along a decreasing freshwater inflow gradient; from the Lavaca-Colorado Estuary in the north, the Guadalupe Estuary in the middle, and the Nueces Estuary in the south. The Nueces Estuary is hydrologically balanced with a long-term salinity averaging 29, in contrast the two northern systems are positive and the average salinity is 20 in the Lavaca-Colorado estuary and 17 in the Guadalupe estuary. Periods were classified as droughts if mean monthly salinities were in the upper quartile of historic salinities. Estuary conditions and benthic response was compared among drought and non-drought periods. Nitrate plus nitrite, and silicate concentrations were lower in drought conditions in Lavaca-Colorado Estuary, but not in the higher saline Nueces Bay. Relative concentrations of phosphate were inconsistent among different climatic conditions. Macrofauna diversity increased in drought conditions relative to other conditions in Lavaca-Colorado and Guadalupe Estuaries. There were no consistent trends in abundance, diversity or community composition among climate conditions; however indicator species for each estuary were identified. White shrimp and blue crabs decreased in mean abundance during drought periods and also changed their spatial distribution. This data indicates that droughts dominate the region and have demonstrable effects on estuary water column condition. While droughts are not important drivers of infauna, there are effects on epifauna; and droughts have a negative affect on primary and secondary production in Texas estuaries.

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GEOSPATIAL DISTRIBUTION OF RIBBED MUSSEL (*GEUKENSIA DEMISSA*) DEMOGRAPHICS AND NUTRIENT REMOVAL SERVICES ACROSS A SALT MARSH LANDSCAPE

Ribbed mussels are ubiquitous in Mid-Atlantic salt marshes where they help maintain clean water, improve habitat for fish and wildlife, and potentially help marshes keep pace with sea level rise. In the Delaware Estuary, ribbed mussels are the functionally dominant bivalve, filtering more water than all other native bivalves combined. Although ribbed mussels are abundant, their densities and demographics are not consistent across the marsh platform. We characterized ribbed mussel demographics and clearance rates across the salt marsh landscape in order to deduce spatial variation in mussel driven ecosystem services. Ribbed mussel demographics, densities, and clearance rates were quantified in three habitats of the marsh platform: Low Marsh River (LMR), High Marsh (HM), and Low Marsh Creek (LMC), and this was repeated seasonally in different areas within and among representative marshes. Clearance rates by mussels of natural seston taken from the same marshes were interpreted in the context of particle removal services (including particulate nutrients) and scaled using allometric relationships to mussel size (dry tissue weights). Ecosystem services furnished by ribbed mussels (evidenced here by bulk particle filtration) were found to vary significantly among habitats within typical marshes. Mussels living in small tidal creeks filtered significantly greater particles per unit time and biomass than mussels living at similar elevation and experiencing similar feeding times along river banks. Mussels living in the high marsh had moderately high particle filtration, but shorter feeding times. Therefore, mussels in small creeks may outperform mussels living along riverbanks and in the high marsh per unit body size.

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ZOOPLANKTON-PHYTOPLANKTON INTERACTIONS IN THE SAN JOAQUIN RIVER, CA

The dynamics of zooplankton and phytoplankton growth and interactions play a significant role in water quality (e.g., pH and dissolved oxygen [DO]) and the available food supply for higher order organisms in the San Joaquin River Delta. Algae have been shown to significantly impact DO in the Deep Water Ship Channel (DWSC) of the San Joaquin River (SJR) estuary. Zooplankton grazing is one of the important mechanisms that influence the fate and spatial distribution of algae, and therefore, may contribute to DO deficits that adversely impact aquatic habitat and salmonid migration in the SJR estuary. Numerical water quality models developed to simulate and predict dissolved oxygen in the SJR rely on mathematical algorithms that link chemical and biological mechanisms. Due to the complexity of natural systems, calibrating these models is challenging and often requires independent investigations to estimate input parameters, such as zooplankton grazing and algal growth rates. This investigation explored the applicability of three methods to quantify the rates that zooplankton graze on algae populations in the SJR. Zooplankton grazing studies were performed in the DWSC of the SJR from June 2012 to July 2013. Light and dark bottle microcosm studies using the dilution method, the food-removal method, and the grazer concentration method were tested. A modified approach similar to the grazer concentration method yielded changes in chlorophyll a concentrations that were sufficient to separate zooplankton grazing from algal growth and respiration. Microcosms contained zooplankton concentrations that were up to 30 times higher than natural, background levels. Zooplankton grazing rates were consistent in both magnitude and variability with literature values reported for other waters, ranging from 1.0 to 4.2 for light bottle microcosms and 0.7 to 4.2 $m^3gC^{-1}d^{-1}$ for dark-bottle experiments.

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A CONCEPTUAL FRAMEWORK FOR EVALUATING THE APPLICABILITY DOMAINS OF ECOLOGICAL MODELS AND THEIR IMPLEMENTATION IN THE ECOLOGICAL PRODUCTION FUNCTION LIBRARY

The use of computational ecological models to inform environmental management and policy has proliferated in the past 25 years. These models have become essential tools as linkages and feedbacks between human actions and ecological responses can be complex, and as funds for sampling have become increasingly limited. A key attraction of ecological models is the ability to apply them in new 'contexts' (i.e., locations, ecosystems, spatial and temporal extents) without having to collect extensive new datasets. There are, however, recognized risks when an ecological model developed in one context is applied in another. In order to better assess this risk we have developed a general conceptual framework that aids in evaluating the potential contextual range of a given model's application, and we have implemented this framework within a database that allows end users to browse, compare and select among ecological models. The framework draws on the "transferability" literature and the importance of a model's "life cycle", as described in the 2007 National Research Council Report, Models in Environmental Regulatory Decision Making. The framework, in the form of a decision tree, assesses a model's conceptual validity (i.e., model type, complexity and structure) during development as well as its evolution and its use in the literature by evaluating its performance (i.e., validation, model comparison and uncertainty) and its similarity in four domains of context: scale, geography, ecology (e.g., geophysical, biotic, etc.), and parameter range or hyperspace. We will showcase the implementation of this framework in the Ecological Production Function Library (EPF-L), a database currently being developed by the U.S. Environmental Protection Agency. Its goal is to provide end users with an array of ecological models and a guided assessment of their applicability to the user's context.

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WHERE DOES IT COME FROM AND WHERE DOES IT GO? DETERMINING NITROGEN INPUTS AND EXPORTS FROM A COASTAL WATERSHED IN TEXAS

Human activities have increased nitrogen (N) input to the coastal ocean, resulting in negative impacts on ecosystem health. To examine the relationship between nitrogen input and export from a coastal watershed in Texas, we utilized the Net Anthropogenic Nitrogen Input (NANI) approach to quantify inputs to the watershed and the U.S. Geological Survey Load Estimator (LOADEST) model to estimate export from the watershed. The Mission-Aransas Estuary is a relatively pristine system located in South Texas and is part of the Mission-Aransas National Estuarine Research Reserve. Forest and agriculture are the primary land use/land cover of these small watersheds, with food (for human consumption) and feed (for livestock) being the largest input of N and fertilizer being the second largest. The high amount of food and feed inputs indicate that riverine N export in the system is driven by sewage and animal wastes, a result that has been confirmed by previous studies in this area. The climate in South Texas is semi-arid with inconsistent precipitation patterns both within and between years. When compared to other watersheds, the total NANI and riverine N export are low. However, large differences can be seen when comparing wet and dry years. The percentage of NANI exported from the rivers ranged from 2% in dry years to 15% in wet years. Although the estuary does not currently exhibit negative impacts due to increased eutrophication, the human population in this area is expected to increase by 44% in the next 50 years. Consideration of population growth, as well as climate change, will be important for understanding potential negative impacts in the future. The NANI method provides a framework for examining future anthropogenic N inputs and estimating N export to the coastal ocean, which can be beneficial for development of potential management practices.

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THE USE OF HIGH FREQUENCY WATER QUALITY MONITORING RESULTS TO IMPROVE THE MANAGEMENT AND MODELING OF SHALLOW WATER HABITATS

Shallow-water regions in the Chesapeake Bay in Virginia (depths <2m) have been monitored over three year cycles since 2003 for water quality constituents including dissolved oxygen (DO), turbidity, pH, chlorophyll, temperature and salinity using continuously recording fixed stations (ConMon) and underway surface mapping (DataFlow). Results have demonstrated more variable and stressful conditions present in the shallows, especially in the summers, than those found in adjacent surface waters. This has important implications for both the living resources in these near shore, shallow water ribbons, as well as the management and modeling programs that strive to improve the water quality of these areas. For example, the combination of short term high temperatures and turbidities in the shallows has been linked to seagrass declines over timeframes as short as days to weeks. Water quality assessments and models developed from traditional low-frequency monitoring data may not capture these events. Low DO levels in the shallows which are stressful to organisms there are many times not present in adjacent surface waters. This may necessitate a change in the current standards which many times assume open surface water conditions extend from shoreline to shoreline. Chlorophyll levels during algal bloom events have been found to be quite variable with levels changing 10-fold or more over the span of a few hours. This suggests that the duration, intensity and recurrence of bloom exposure to shallow water benthic organisms must be considered in evaluating impacts and in setting standards for water quality improvements. High frequency, shallow water monitoring is an essential tool to further our understanding of the Chesapeake Bay ecosystem. Due to the inherent short-term spatial and temporal water quality variability which can have critical ecological implications here; this type of monitoring is a necessity in the effective management of these shallow regions.

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DISTRIBUTION AND AMOUNT OF PLASTIC PELLETS AND DEBRIS ON BEACHES IN CALIFORNIA

Beach debris has become a focus of concern in coastal areas around the world. In particular, the presence of plastic debris on coastal beaches, especially in the form of pre-production plastic pellets, has been identified as an environmentally relevant issue in California. As such, Assembly Bill 258 was passed in 2007, requiring the State Water Resources Control Board (SWRCB) to monitor and regulate the discharge of plastic pellets into the environment. Developing baseline information on debris and pre-production plastic pellets is a necessary and critical step in beginning the regulating and monitoring process. The goal of this study was to determine the abundance and distribution of beach debris and pre-production plastic pellets, along the entire coast of California. Sixty randomly selected sites were sampled between June 29 and October 7, 2009. In general, beach debris was widespread throughout the state; however, it was found in larger amounts near highly populated and urbanized areas. Pre-production plastic pellets were not as widespread throughout the state but were more localized to specific areas. We estimated that approximately 210 million plastic pellets on California beaches. Of this total, about 98% of all pre-production plastic pellets were recovered in the Southern California region. This result is highly reflective of the large concentration of plastic facilities also located in Southern California. This study identified areas of concern for debris and pre-production plastic pellets and provides baseline information necessary for accessing how management actions are progressing. Additional investigation will be necessary to determine the extent of the problem in those areas where these items were found in large numbers and to determine if management action are working.

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MECHANISMS THAT INFLUENCE PH AND ARAGONITE SATURATION STATE IN THE STRAIT OF GEORGIA

A 1-D vertical biophysical coupled model is used to investigate the seasonal, interannual, and long-term variability of pH and aragonite saturation state (Ω_{arg}) in the southern Strait of Georgia, British Columbia. The Strait is a semi-enclosed coastal basin that is highly stratified throughout most of the year due to large outflows from the Fraser River. The model is initialized using casts from local sampling programs, and continuously forced with local

meteorological and river discharge observations. Dissolved inorganic carbon (DIC) and total alkalinity are modeled as scalar quantities and used to calculate pH and Ω_{arg}. Model results show an Ω_{arg} = 1 horizon at ~10 m that shoals to the surface during winter and sometimes in summer during large freshets. pH is high (> 8) near the surface in spring/summer/fall and low (< 7.7) below 10 m due to entrainment of DIC-rich water from the intermediate layer. Sensitivity studies suggest a seasonal succession of forcing dominance on surface pH and Ω_{arg}. In spring, pH is strongly anticorrelated to windspeed due to mixing across the large, shallow pH gradient. In late spring and early fall, pH is correlated to river discharge due to stratification, however during the freshet, pH and river discharge are anticorrelated due to dilution. The deepening of the Ω_{arg} = 1 horizon below the surface in early spring appears to coincide with the onset of the spring diatom bloom, and the summer surface Ω_{arg} < 1 duration is clearly a function of river discharge. pH and Ω_{arg} in the Strait are also sensitive to the DIC concentration below the model domain. While the relative contribution of DIC to these intermediate waters by inflow from below the continental shelf-break is not quantified in this study, long-term increases in mid-depth DIC on the same order as those observed in the ocean can produce local changes in pH and Ω_{arg} = 1 horizon depth that match or exceed the variability on seasonal timescales.

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PLASTICITY OF EUROPEAN FLOUNDER LIFE HISTORY PATTERNS DISCLOSES ALTERNATIVES TO CATADROMY

Otolith microchemistry has become a frequently used tool to infer fish life history. Yet, life history plasticity (i.e. variation or flexibility) is among the less explored topics using this method. The European flounder Platichthys flesus is one of few species known to exhibit, at a basin scale, several life history tactics. Our objective was to quantify flounder life history plasticity along a broader latitudinal gradient (Minho- Portugal, Gironde and Seine- France), using LA-ICP-MS-derived coupled Sr:Ca and Ba:Ca otolith signatures and microstructure to retrospectively infer habitats occupied during their life. Flounder exhibited high life history plasticity between and even within basins, apparent by the diversity of habitats used during larval ontogeny and throughout their lives, and by the age at which they migrated to freshwater. Egg signatures probably had a strong maternal influence, and we propose that flounder spawned and/or hatched predominantly in brackish waters in the Minho basin, while in the Gironde and Seine basins, flounder spawned and/or hatched either in coastal, brackish or freshwater habitats. During pre-metamorphosis and metamorphosis, flounder were predominantly in brackish waters in the Minho, and mainly in coastal and freshwater habitats in the Gironde and Seine, respectively. The diversity of flounder life histories (i.e. sequence of habitat residence: freshwater, brackish or coastal) after metamorphosis was similar between basins (Minho- 13, Gironde- 13, Seine- 14). Flounder migrated to freshwater at an earlier age in the Minho and Gironde (<0.5 yr old) while in the Seine, flounder migrating from the coast into freshwater reached maximum frequencies at age 1.3 yr old. Our interpretations of data refute the current theory that flounder spawn exclusively in coastal waters. So, we suggest that the European flounder is a facultative catadromous species, rather than the previously thought obligative behavior.

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ASSESSMENT OF THE TROPHIC STATUS OF COSTAL ECOSYSTEMS IN THE GULF OF MEXICO AND CARIBBEAN (MEXICAN SIDES)

Coastal ecosystems of the Mexico in the Gulf of Mexico (GoM) and Caribbean Sea (CS) regions are important both ecologically and economically. The biological diversity, high productivity, and ecosystem services provided by these tropical coastal systems in both regions (GoM, CS) are well recognized. However, these characteristics promote human settlement, urban development and tourism of high impact (Cancun). In order to assess the eutrophic condition of 24 coastal ecosystems the trophic index (TRIX) and water quality index were applied using data published and from the CINVESTAV Labs. The results indicate that the current status of the coastal ecosystems of these regions is in general oligo-mesotrophic. In GoM the lagoons from Yucatan are less eutrophicated, where the condition was oligotrophic/meso-eutrophic; Campeche as well as Tamaulipas exhibited mesotrophic to meso-eutrophic condition; Tabasco was mesotrophic, meanwhile Veracruz was the most eutrophicated location. In the case of CS lagoons the general condition was meso-eutrophic. The main symptoms of eutrophication in the ecosystems analyzed were high concentrations of ammonium, phospate and Chlorophyll-a. Although they have many features in common, including the regional climate and the presence of groundwater inputs, each lagoon is affected by human activity in a different way. Most of the coastal ecosystems analyzed showed impacts over the watersheds and basins of rivers and aquifers. The main impacts were associated to the urban waist waters and fertilizers used for agriculture and livestock activities. Until now there is no information on the impacts on the biodiversity and other ecosystem services.

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DIFFERENTIAL TRANSPORT ACROSS THE SURF ZONE OF REFLECTIVE AND DISSIPATIVE SHORES AS A DETERMINANT OF LARVAL SUPPLY

We determined whether differences in water exchange across the surf zone on dissipative and reflective shores regulates larval supply to intertidal populations. We surveyed zooplankton daily for one month relative to physical conditions inside and outside the surf zone at a dissipative and reflective beach near Monterey, California. Larvae of some species completed development nearshore while larvae of other species migrated offshore and back. Concentrations of zooplankters were much greater outside than inside the surfzone at the reflective beach, indicating that the surf zone may block onshore transport. Barnacle cyprids were an exception, suggesting that ontogenetic changes in larval behavior may facilitate penetration of the surf zone. In contrast, zooplankters were 1 to 2 orders of magnitude more concentrated inside the surf zone of the dissipative beach. Settlement of barnacles on rocks at both beaches was low, and settlement of sand crabs was abundant only on the dissipative beach. Different hydrodynamics of surf zones at dissipative and reflective beaches together with larval behavior may play a key role in regulating larval supply along the West Coast.

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REWORKING OF FLOOD DEPOSITS ON THE WAIPAOA SHELF, NEW ZEALAND: BUOYANT AND GRAVITY-DRIVEN FLUXES

Riverine deposits on continental shelves reflect terrestrial signatures, but are typically modified by the marine environment. Partitioning between various transport mechanisms (dilute suspension vs. gravity-driven) may influence the location and characteristics of these deposits. The MARGINS Waipaoa River shelf initiative investigated these issues by conducting a thirteen month field campaign, and an ongoing numerical modeling study of the Waipaoa River shelf, NZ. This study used two numerical models to analyze sediment fluxes and fate on the continental shelf from January 15, 2010 – February 15, 2011, during which three large floods and multiple high wave events occurred. Water-column fluxes were estimated using the Regional Ocean Modeling System- Community Sediment Transport Modeling System (ROMS - CSTMS) model. This three-dimensional hydrodynamic-sediment transport numerical model accounted for gravity-driven transport by incorporating sediment concentrations into the model's equation of state. To resolve fluxes within the thin wave-current boundary layer, however, it was necessary to use a near-bed turbid layer model based on the Chezy equation, which balances friction and gravity. Buoyant fluxes within the water column distributed sediment along-shore to the inner and mid-shelf, depositing material up to about 50 m water depth. Wave- and current- supported gravity flows, in contrast, could export sediment to long-term shelf depocenters (50 – 70 m water depth) and the continental slope. Sensitivity tests indicated that erodibility parameterization and sediment settling velocity significantly affected buoyant sediment fluxes. Estimates from the near-bed turbid layer model were sensitive to assumptions about the distribution of sediment delivery from the river in terms of the initial deposit and percentage of the riverine load available for gravity driven transport.

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WHAT GEOSPATIAL ANALYSES REVEAL ABOUT THE VULNERABILITY OF COASTAL WETLANDS TO SEA-LEVEL RISE

We are developing novel ways of visualizing the vulnerability of coastal wetlands to sea-level rise. The vertical distributions of a marsh landscape and its vulnerability can be modeled by spatially explicit analyses of their relationships to tidal datums or frequency distributions. The resulting skewness statistic of frequency distributions of relative elevation expresses the degree to which a vegetated marsh landscape is focused near its vertical limits. Negative skewness is a characteristic of a stable state and relatively high elevations, positive skewness denotes a high degree of vulnerability and relative elevations that approach the lower limit of the vegetation. The advantage of the skewness statistic is that it does not require knowledge of local tidal datums. Alternatively, the modal elevation (Em) of a landscape can be normalized (En) to the dimension of the tidal frame, expressed as -1 to 1 where 0=MSL and 1=MHW, or En = (Em - MSL)/(MHW-MSL). Both statistics can be visualized with GIS. One of the unknowns is how the visualizations and interpretation are affected by scale. A map can be produced at a very fine scale (if the LiDAR data are dense), say 25 x 25 m, or 100 x 100, or at the scale of an entire landscape uint (e.g. a creekshed). Is one scale best? Real examples of the different types of distributions will be shown, drawn from LiDAR data coverage of North Inlet, SC, New River estuary, NC, Savannah River, and Plum Island estuary, MA.

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USING COMPARATIVE GENOMIC AND METAGENOMIC-BASED APPROACHES TO EXAMINE EFFECTS OF COPPER POLLUTION ON MARINE BACTERIA

Coastal ecosystems contain elevated levels of copper, mostly due to leaching and runoff of heavy-metal based biocides used in agricultural and boating industries. Because copper is naturally present in dilute concentrations, slight increases can be toxic to marine bacteria. Some bacterial populations have the ability to tolerate elevated levels of copper, enhanced by chronic exposure. Microbial samples taken from three Southern Californian kelp forests - Point Loma (high copper pollution), La Jolla (intermediate copper pollution) and Catalina Island (low copper pollution) - were tested for copper tolerance using MIC assays. Results showed that Point Loma bacteria demonstrate the highest copper tolerance, samples from La Jolla demonstrated a lower copper tolerance, and samples from Catalina demonstrated the lowest copper tolerance, as predicted. It was hypothesized that an enhanced tolerance to copper expressed in the phenotype would correspond with a higher number of genes associated with copper tolerance. Genomes of seven bacterial isolates show no significant differences for the number of genes involved with virulence, disease and defense, suggesting that bacteria may tolerate copper utilizing different mechanisms. In model microorganisms, such as E. coli, copper tolerance operons which require specific genes to maintain proper function have been identified. Our sequenced environmental genomes share operons identified in E. coli; however, the genes are not conserved among the genomes. Two operons which are complete in copper tolerant E. coli organisms but incomplete in our environmental organisms include the scsABCD operon (suppression for copper sensitivity) as well as the CutACFE operon (cytoplasmic copper homeostasis). This suggests that our understanding of genetic mechanisms for copper tolerance in model bacterial organisms may not hold true for less studied environmental bacteria.

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U.S. IOOS CONTRIBUTIONS TO MONITORING WATER QUALITY INCLUDING NUTRIENTS AND HARMFUL ALGAL BLOOMS

The many facets of water quality present considerable management challenges in the coastal waters of the United States especially in estuarine and nearshore environments. The U.S. Integrated Ocean Observing System (IOOS®) including the eleven Regional Associations, the U.S. IOOS Program Office, and the Alliance for Coastal Technologies are observing, modeling, forecasting, and integrating water quality parameters across a variety of temporal and spatial scales. Nutrient and oxygen sensors have been evaluated and deployed to assess a variety of conditions including eutrophication, hypoxia, and changes in water masses. Autonomous measurements of optically significant constituents have revealed correlations between water clarity and environmental conditions important to understanding eelgrass survival. Harmful algal bloom (HAB) sensors have warned of outbreaks of potentially life threatening blooms and are being pushed down the continuum from research to operations. Modeling and forecasting of water quality continues to improve through efforts in regions coordinated with federal agencies and through programs such as the IOOS Coastal and Ocean Modeling Testbed (COMT). The challenge in the next few years is to continue to build nationally consistent capacity to observe, model, and forecast water quality by building on local, state, regional, and federal efforts.

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ARE SALT MARSHES SINKS OR SOURCES OF GREENHOUSE GASES? HOW SHIFTS IN GREENHOUSE GAS FLUXES FROM COASTAL ECOSYSTEMS MAY AFFECT THE PROMISE OF BLUE CARBON

Coastal salt marshes are prominent targets of "Blue Carbon" initiatives that aim to maximize carbon sequestration in marine ecosystems, but they can emit significant quantities of greenhouse gases (GHGs). Sharp environmental gradients that define salt marsh ecosystems offer the opportunity to test how GHG fluxes may vary from these coastal ecosystems in response to changes in inundation, salinity, and shifts in plant community composition. GHG fluxes were compared between two distinct ecological zones of three New England salt marshes (a *Spartina patens* and *Distichlis spicata*-dominated "high" marsh and a *Spartina alterniflora*-dominated "low" marsh). Vertical emissions of CO_2, N_2O, and CH_4 were measured in situ for two growing seasons using static flux chambers connected to laser absorption spectroscopy analyzers in three New England salt marshes. These marshes, in Waquoit and Narragansett Bays, varied significantly in the extent of anthropogenic nitrogen loading. The most pristine site was frequently a sink for CO_2, and GHG fluxes did not differ between major zones. In contrast, the two marshes with highest anthropogenic N loads, all three vertical GHG fluxes were significantly higher from the more productive low marsh zone than the high marsh zone. Significantly higher N_2O (as well as trends of higher CO_2 and CH_4 fluxes) were observed in the marsh with the greatest anthropogenic N loading. The highest of these emissions is comparable to approximately one-third of typical daily C sequestration rates reported for salt marshes, suggesting that greenhouse gas fluxes may warrant consideration in potential Blue Carbon projects.

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EFFECTS OF ELEVATED CO_2 AND NITROGEN ON *PHRAGMITES AUSTRALIS* INVASION

Coastal plant communities are very sensitive to environmental change. Recent evidence suggests that global change-induced species shifts may alter the ability of wetland ecosystems to persist in a rapidly changing climate. At the same time, coastal wetlands are also under siege by an introduced lineage of the common reed, *Phragmites australis*, which has the potential to be a "game-changer" due to its ability to change both the structure and function of tidal wetlands. While earlier global change studies provide clear insights into the responses of native plant communities to both CO_2 and N, little is known how another global change factor, invasive species, may alter ability of coastal wetlands to persist or respond to predicted global change. To evaluate how the process of invasion may change with both predicted levels of both CO_2 and N pollution, we began a fully factorial open top chamber (OTC) elevated CO_2 x N experiment in a brackish Chesapeake Bay tidal marsh in May 2011. OTC's were deployed along the invasion edge of *Phragmites* into a native Chesapeake Bay marsh community and exposed to factorial treatments of CO_2 (ambient or ~720ppm CO_2) and N (ambient or +25g N m-2 yr-1). We present data from the first two years of treatment on *Phragmites* invasion into the native plant community. Our analysis indicates a strong invasion response in *Phragmites* density to N pollution (p=0.003). *Phragmites* also responded instantaneously with increased photosynthetic rates to elevated CO_2, but growth responses to elevated CO_2 were more subtle (p=0.08). Given the well-documented shifts belowground with elevated CO2, we expect rates of invasion to intensify with time with elevated CO_2. Our data suggest that both nitrogen pollution and elevated CO_2 will increase rates of *Phragmites* invasion in brackish marshes. Given the strong invasion response to N pollution, management efforts should be targeted at limiting N loads to limit future *Phragmites* invasions into tidal wetlands.

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PRINCIPAL COASTAL FUNCTIONAL ZONING BASED ON MULTIDIMENSIONAL DECISION-MAKING APPROACH

With rapidly socioeconomic development and increasing population, the resource use conflicts and ecosystem degradation in coastal area are already clear in China. There is an urgent need for a fundamental shift in the way and intensity of coastal development towards sustainability. The principal coastal functional zoning (PCFZ) would be an available approach for coastal sustainable development. In order to regulate and optimize the spatial pattern and intensity of regional development, principal functional zoning (PFZ) was proposed by Chinese Government in 2006. However, no generally accepted definition and approach of PFZ or PCFZ is available. Based on the experience from the international efforts in ocean zoning, marine (and coastal) spatial planning, and marine functional zoning, this article discusses the concepts, principles, purpose and contents of PCFZ, proposes an approach to PCFZ based on multi-dimensional decision-making approach (MDDM), a new approach for strategic decision-making analysis, and applied it into two case studies in the coastal areas of Xiamen Bay and Luoyuan Bay, Fujian Province, China. The results showed that the approach and methods for PCFZ based on MDDM could be used in any complex system for regional and integrated strategic decision-making with complex environmental conditions and attributes, high uncertainties and non-structured decision-making processes, provide a technical support to develop PCFZ, a strategic decision-making process. PCFZ divided coastal zone into different types of functional zone(s) including principal function to identify the priority-use and non-principal functions to allow multiple compatible activities occurring in the same zones. Moreover, PCFZ identified the development intensity of each function, and considered the ecological compensation for the limited industries and ecosystem for PCFZ implementation.

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CAP: THE FORGOTTEN FRACTION IN MODELING SEDIMENT-WATER PHOSPHORUS FLUX IN SHALLOW COASTAL ESTUARIES

The western Wadden Sea experienced reduction of riverine dissolved inorganic phosphate (DIP) loadings over the last decades. Consequently pelagic primary producers experience periods of phosphorus (P) limitation. Understanding the sediment P dynamics in this system is essential, as it directly controls the sediment-water DIP flux and thus fuels pelagic primary production. Numerical simulation models are proven tools for predicting response to changing nutrient loading. In most models the sediment DIP release is a function of adsorption and desorption onto iron hydroxides. This may be an oversimplification when the estuary is characterized by intertidal flats that are inhabited by microphytobenthos (MPB) communities. Benthic primary production can generate high pH with potential loss of bioavailable P through calcium phosphate (CaP) precipitation. We hypothesize that this process is important for predicting the sediment-water DIP flux on multiple time scales. Therefore, we developed a simple numerical 1D-model of the sediment-water interface that included aerobic and anaerobic mineralization, sorption processes and precipitation of DIP in a CaP fraction. MPB production was included as a forcing factor. The model was tested against a measured dataset on DIP fluxes, P fractionation, pore water and water column DIP concentration and chlorophyll a analyses acquired through one year of repeated field campaigns at an intertidal flat. The results suggest that sorption processes can explain the major changes in DIP flux on short time scales (within days), but are insufficiently able to simulate the variation on longer time scales (yearly). Model results improved significantly for longer time scales when CaP fraction was included and in periods when flats were net autotrophic, especially when net autotrophy coincided with pelagic spring bloom. This suggests that CaP should be considered when modeling the response to changing nutrient loadings in shallow coastal estuaries.

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HYDROACOUSTIC SYSTEM FOR QUANTITATIVE IDENTIFICATION OF AQUATIC MACROPHYTES, SUBSTRATE COMPOSITION, AND BATHYMETRIC SURVEYING

Demand for fine-scale mapping tools to accurately assess the ocean floor has grown steadily as critical aquatic habitat areas and other natural resources have become increasingly scarce. Hydroacoustic techniques are widely used and well proven in this capacity. Valuable seafloor mineral deposits can be located based on identification of specific substrate features and sonar-based substrate classification has thus become an area of intense focus by the burgeoning seafloor mining industry. The composition of seafloor substrate is also directly related to the viability and quantity of aquatic habitat. Effective protection and management efforts require a baseline understanding of the existing quantity and location of these areas. A hydroacoustic survey was conducted to assess eelgrass and macrophyte coverage, bathymetry and substrate composition. A calibrated single beam echosounder with 200 kHz single beam transducer and integrated DGPS was used for data collection. Data were processed using Visual Habitat software using satellite imagery overlain with each transect file and a synchronized echogram. Substrate classification was performed using a Principal Components Analysis (PCA) of each echo signal and clustering based on similarities of the components. This resulted in the delineation of areas with similar acoustic properties based on relative hardness and smoothness of seafloor. Vegetation canopy height was identified via the shift in signal strength of each echo through the water column. Plant density was calculated based on the presence/absence of vegetation per sample contained in a report cycle. Bathymetry was recorded with an accuracy of +- 1.7 cm. Processed data were exported to CSV and KML files. Results showed high agreement with ship's depth sounder readings, visual observation, and simultaneous video recordings.

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THE STATE OF THE ESTUARY: COMMUNICATING ENVIRONMENTAL HEALTH AND TRENDS TO THE INTERESTED PUBLIC

The State of the Estuary is a periodic report of the New York-New Jersey Harbor & Estuary Program on the status and trends of environmental indicators for this estuary. With limited available resources, and in the absence of a network specifically designed to keep track of the overall environmental condition in the estuary, this report makes use of already established monitoring programs, thus piecing together multiple datasets (e.g., water quality and fish populations). The main goal of the State of the Estuary is to make existing information about the environmental status and trends of the most urbanized estuary in the U.S. (the NY-NJ Harbor) accessible to the layperson while serving as an educational and outreach tool. Thus the report strives to depict the estuary's health in a concise, non-technical, and visually appealing manner. Contextual information includes a historical background, ongoing and planned management actions, clear connections between the health of the estuary and people's daily lives, and tips on simple actions everyone can take to be part of the solution. The State of the Estuary is also intended to increase support among the interested public and elected officials for the types of measures needed to improve the ecological condition of the estuary, by broadening awareness of the issues affecting the estuary and by promoting stewardship of the shared resources on which everyone's wellbeing depends. In an attempt to reach a broader audience, one-page summaries were produced, in English and Spanish, as well as an expanded version with full citations. The approach to dealing with multiple challenges will be discussed, including data scarcity, lack of adequate spatial and temporal data coverage, and data quality issues. The overall challenge of presenting complex data and concepts in a simple and engaging fashion will also be addressed. An indication of the success of this report will be presented, as well as plans for increasing its impact.

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OYSTER MORTALITY IN DELAWARE BAY: IMPACTS AND RECOVERY FROM HURRICANE IRENE AND TROPICAL STORM LEE

Climate change is predicted to bring increased frequency and intensity of storms, the ecological and economic consequences of which will be important to understand and predict. Multidisciplinary research strategies, such as the one described here, will increase mechanistic understanding of storm impacts and provide recovery trajectories that can be

used for preparation, planning and management. In 2011, Hurricane Irene and Tropical Storm Lee generated extreme flooding in the Delaware River watershed that produced prolonged baywide low salinity and historically-high mortalities for the oyster stock in the upper reaches of Delaware Bay. The mechanisms, dynamics, and projections for recovery from the high mortality are reported using a combination of physical modeling, long-term field sampling, and metapopulation dynamics modeling. Oceanographic modeling provided hindcast calculations of salinity exposure across the range of oyster beds in the Delaware Bay. Continuous low salinity (<7) exposure in excess of 20 days was associated with monthly oyster mortality on the upper bay beds that exceeded long-term averages (10% at Arnolds, 55% at Hope Creek). More than 75% of the oysters that died in the most heavily impacted areas were large, market-sized (>63.5 mm shell height) oysters; thus, the mortality event generated a large shift in both abundance and population structure in the upper beds. Population recovery projections based on metapopulation modeling suggests that recovery will take ~10 years for the uppermost beds, an area of the bay which comprised about 34% of New Jersey's commercial oyster fishery before the flood. Clear understanding of the circumstances leading to this high population-level impact on oysters is important because anticipated future conditions of increased storm frequency will intensify the challenge such events pose for the management of fishery and aquaculture resources, and the siting of restoration efforts.

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SALMON, SEAWALLS, AND SEATTLE: ASSESSING THE EFFECTS OF SHORELINE MODIFICATIONS ON THE ECOLOGY OF FISH IN ELLIOTT BAY, WASHINGTON

Shoreline modifications such as armoring and overwater structures are becoming increasingly prevalent to support infrastructure aggregated on coasts worldwide. Despite the global prevalence of shoreline modifications, their effects on nearshore ecosystems are poorly understood. My research explores the effects of seawall armoring and piers on fish and crab assemblages in the urbanized estuary of Elliott Bay, Washington within Puget Sound. Among the species studied are juvenile Pacific salmon, which depend on the estuary for foraging, predator refuge, and salinity acclimatization as they outmigrate along the shore. Utilizing snorkel and scuba observation methods, our research suggests shoreline modifications affect the distribution, behavior, and assemblage structure of fish and crabs, including juvenile salmon. The Elliott Bay Seawall will be reconstructed in late 2013 and will include habitat enhancements to reduce its ecological impact. Seattle's significant and prominent investment in reducing the impact of its iconic waterfront provides an ongoing case study on the effects of shoreline modifications and attempts to mitigate their impacts. Efforts to enhance the waterfront habitat also provide opportunities for broad scale messages on the importance of investing in sustainability and to reconnect people to the water.

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BIOGEOCHEMICAL RESPONSES TO CLAM AQUACULTURE: SACCA DI GORO, ITALY AND CHERRYSTONE INLET, US

As bivalve aquaculture expands globally, understanding how large-scale aquaculture operations alter the fate of nitrogen is important to maintain sustainability and minimize detrimental impacts on sediment and water quality. Whether bivalve aquaculture enhances rates of denitrification and therefore is an effective means to remove nitrogen from an aquatic system, is unclear. The effects of clam aquaculture on the biogeochemical cycling of nutrients are strongly influenced by the specific culturing techniques used as well as local environmental conditions. A comparison between a clam aquaculture operation based in the US and one in Italy demonstrates the challenge in generalizing nutrient cycling responses within these grow-out sites. Hatchery-reared Mercenaria mercenaria are cultured in Cherrystone Inlet, VA on the Chesapeake Bay-side of the eastern shore under predator exclusion nets and harvested after two years. Ruditapes philippinarum juveniles, grown in the Sacca di Goro located in the northern Adriatic Sea, are collected from natural sets outside of the lagoon and planted in privately leased plots within the estuary. High respiration rates were observed at both sites and seasonal blooms of macroalgae were a major problem in both estuaries. Greatly influenced by nitrate availability, rates of dentrification and dissimilatory nitrate reduction to ammonium (DNRA) were generally higher in the Sacca di Goro, likely due to the higher nitrate concentrations in the water column compared with Cherrystone Inlet. The strong coupling of denitrification and DNRA with nitrification limits these pathways in Cherrystone Inlet due to highly reduced sediments. The high rates of nutrient regeneration observed at both culture sites, which likely stimulate local macroalgal blooms, should be considered when assessing the overall nitrogen removal rates at clam aquaculture sites.

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SEASONAL VARIABILITY IN CO_2 SENSITIVITY IN EARLY LIFE STAGES OF A COASTAL MARINE FISH: A CASE OF TRANSGENERATIONAL PLASTICITY?

How marine fish will be affected by the anthropogenic rise in pCO2 in the ocean is still largely unknown. We studied the effect of elevated pCO2 levels on Atlantic Silverside Menidia menidia embryos and early larvae during two years of repeated exposure experiments. Ripe adults were collected on a semi-lunar basis throughout the 2012 and 2013 spawning seasons (April – July) and strip-spawned ~24h post collection. In a total of nine fully replicated experiments newly fertilized embryos were exposed to low, middle or high pCO2 levels (~500, ~1000, ~2200 µatm) and reared at 24°C and excess food until 10 days post hatch. During both years, offspring of adults collected early in the season displayed a significant reduction (55% 2012, 33% 2013) in survival when reared at high compared to low pCO2 levels. However, this effect gradually diminished as the season progressed, and all but disappeared by the end of May. Then, larvae reared in high pCO2 had similar survival as those reared under low pCO2. We hypothesize that the seasonal decrease in early life CO2 sensitivity may reflect parental conditioning of offspring (i.e., transgenerational plasticity), given that average pCO2 levels in our coastal study area (Flax Pond, Long Island, 40°58'N, 73°8'W) increase predictably throughout the spawning season of M. menidia due to the onset of biological production. The entirety of our experiments suggests that coastal fish species like Atlantic Silversides exhibit adaptive mechanisms to cope with the large natural fluctuations in CO2 conditions typical for coastal habitats.

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RESEARCH EXPERIENCES FOR STEM STUDENTS

Reports suggest that relatively few students relate to scientific concepts or understand scientific processes, resulting in a precipitous decline in interest and expertise in Science, Technology, Engineering, and Mathematics (STEM) disciplines (TIMSS 2009(National Academies 2010). Partnerships between scientists and teachers can help bridge the gap between current research and the secondary classroom and provide students with an understanding of the scientific process, ultimately improving student achievement in STEM disciplines. The goal of our Research Experiences for STEM Students (RE STEM) pilot program is to enhance student interest in STEM through the exposure of research- and inquiry-based ocean science experiences for high school Advanced Placement (AP) students and their teachers. The RE STEM program blends expertise from a higher education research facility with expertise from local school districts to develop and implement student research projects for existing AP Biology and Environmental Science STEM courses. These activities introduce students to the practice of authentic ocean science research and incorporate skills used by ocean research scientists, including problem formulation and solving, mathematics and use of high technology instrumentation. The components of the RE STEM program include a week-long Summer Institute for AP STEM teachers and classroom based Student Research Projects for AP students. The Institute introduces teachers to the scientific process through hands-on research projects and develops the implementation plan for project integration into the AP Biology and Environmental Science curricula. The RE STEM program teachers and staff implement the Student Research Project in the AP STEM courses offered by partnering school districts during the school year. The program culminates with a student visit to the UMCES HPL research institution so that students can explore the research world first hand.

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ENVIRONMENTAL DRIVERS OF VARIABILITY IN ESTUARINE METABOLISM GLEANED FROM IN SITU AND EXPERIMENTAL MEASUREMENTS AT PAIRED SITES IN A WARM TEMPERATE PENSACOLA BAY, FLORIDA

We investigated integrated ecosystem properties (gross production, respiration, and net ecosystem metabolism) in the Pensacola Bay estuary, using a combination of instrument deployments and plankton metabolism experiments. High-frequency water quality data were collected from April to September 2013 at paired sites chosen to represent a contrast between a shallow (<2 m) seagrass site and a nearby site in deeper water. Each in situ instrument measured temperature, salinity, dissolved oxygen (DO), depth, chlorophyll fluorescence and CDOM fluorescence every 30 minutes. Additionally photo-synthetically active radiation (PAR) was measured at 2 depths per site to characterize water column light attenuation. A weather station at the nearby laboratory dock to measure temperature, wind speed, and PAR. Plankton primary production and respiration experiments were conducted with site-collected water at weekly intervals, using the light-dark oxygen technique and were related to estimates of metabolism inferred from the high frequency DO data using the open water method. The data will be analyzed to examine wind-based parameterization of air-sea oxygen exchange rates and how variability in water quality constituents relate to ecosystem metabolic rates. Comparisons will be made among bottle measurements and shallow vs. deep site open water metabolism estimates with the hypothesis that differences may be related to benthic (including seagrass) productivity. Also of interest is whether periodic differences in light attenuation at the channel and shoal sites are associated with wind-driven sediment resuspension, because such differences have implications for understanding the light field available to seagrass. Finally, the results from this study will be compared to estimates of water quality and process rates simulated using EFDC/WASP simulation models of Pensacola Bay.

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PIKEPERCH (*SANDER LUCIOPERCA* (L)) IN DECLINE-HIGH MORTALITY OF THREE POPULATIONS IN THE NORTHERN BALTIC SEA

The development of three pikeperch (Sander lucioperca (L.)) populations in the northern Baltic Sea was monitored using standardized multimesh gillnets in 1995–2009. Declining trends in the abundances of pikeperch over 40 cm total length, low numbers of individuals older than six years, and high mortality rates were observed in all three populations. In the site with the largest commercial catches per unit area and a rapidly increased colony of great cormorants (Phalacrocorax carbo sinensis Blumenbach 1798), also the abundance of pikeperch below 40 cm total length and year-class strength showed declining trends. The adverse population level changes did not correlate with changes in water quality or eutrophication status. Together, the results suggest that in all study sites fisheries are harvesting a large proportion of the pikeperch soon after or even before reaching the maturity, and that predation from great cormorants may increase mortality of juveniles. Pikeperch is important not only for fisheries but also for ecosystem functioning, and our results point at the need for further management measures to ensure viable populations in the areas studied.

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USING HIGH SPATIAL RESOLUTION SAMPLING TO VALIDATE THE LOCATIONS OF PERMANENT WATER QUALITY MONITORING STATIONS WITHIN THE MISSION-ARANSAS ESTUARY

Located in south Texas, the Mission-Aransas estuary is a relatively pristine estuary with low flushing rates, where annual evaporation often exceeds inputs from precipitation and the combined inflows from the Mission and Aransas Rivers. However, episodic rain events can cause significant pulsing of nutrients and organic matter into the system that has been shown to stimulate ephemeral increases in phytoplankton biomass. Using five permanent monitoring stations positioned throughout the estuary, high temporal resolution hydrographic data are currently being utilized to assist in the development of a numeric nutrient criteria for Texas estuaries. Given that the Mission-Aransas estuary is comprised of approximately 100,000 acres of water, it is important to validate how accurately our monitoring stations represent the system as a whole. To do this we have built an along-track data collecting system which allows us to sample water quality parameters with a 1/4km resolution while traveling between monitoring stations for bimonthly servicing. Our inexpensive solution utilizes an auxiliary 6600 YSI data sonde to sync GPS locations with instantaneous measurements of surface water chlorophyll, dissolved oxygen, turbidity, temperature and salinity at 15 second intervals from aboard a small (<30ft) vessel. This system is currently being used to determine how well our permanent monitoring stations represent changes in the estuary, as well as discover additional points of interest which may require additional observation in the future.

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RESEARCH AND EDUCATION FOR STUDENTS AND TEACHERS ABOUT THE ORMOND BEACH RESTORATION (RESTOR) PROJECT

Initiated in 2008, the RESTOR Project is a middle school teacher and student watershed education program focused on the Ormond Beach wetland restoration, southern California's largest wetland restoration effort. The RESTOR Project implements a tiered mentoring approach with participation from non-profit groups, community members, Oxnard City Corps youth, and university students and faculty. It educates local teachers and the mostly low income, multicultural, middle school students who live in the area about wetlands, watersheds and water quality through hands-on education (both in the classroom and the field), native plant restoration and water quality research. It includes teacher workshops, teacher field research, classroom visits by a local water quality expert, a student field trip to Ormond Beach and a student research cruise to the Channel Islands. Recently the RESTOR Project initiated a wetland restoration effort adjacent to Ormond Beach led by a CSUCI professor and students, which will allow middle school students, teachers and community members to directly participate in restoring a wetland in the Ormond Beach area. This is useful because the large Ormond Beach restoration effort is not yet underway. Since Ormond Beach is surrounded by industrial and agricultural development most of the low-income, multicultural population that live near this area are unaware of its existence. A broader goal of the project is to increase public awareness and support for the restoration and public access to the site. Results from the RESTOR project will be presented.

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ANALYSES OF LONG-TERM CHANGES IN PHYTOPLANKTON DIVERSITY AND BIOGEOGRAPHY IN TROPICAL ESTUARINE AND COASTAL REGIONS

Inherent variability within an ecosystem, hydrographic aberrances, seasonal cycles, and anthropogenic perturbations lead to community shifts, species dominance and/or recessive exclusion of flora and fauna in any given region. Data available from major estuaries along the east and west coasts of India for the 1980-2010 period were analyzed for this study. Analyses on chlorophyll a concentrations, abundance, distribution and species composition of phytoplankton assemblages, nutrient concentrations and salinities in these monsoon affected tropical estuaries were carried out to elucidate shifts, if any, in the composition of different groups in relation to altered physico-chemical characteristics. Strong variations in salinity concentrations of chlorophyll a, and micronutrients were implicit for this 30 year period, mostly in response to monsoonal forcing. Dramatic dominance shifts in many diatom genera, compositional variability and diatom:dinoflagellate ratios were evident. Although the generic diversity of diatoms is substantive, only a few of them have become predominant over the years in many estuaries. Occurring all through the year, pennate diatoms are far more numerous, and widely distributed suggesting their persistence even during low nutrient

levels and/or unfavorable salinities. Apparently, Skeletonema costatum and Chaetoceros curvisetus have become established in most locations. Our analysis implies that such response by a few groups is due to nutrient [and pollutant] enrichment pulses in/around many of these locations. Principal component analysis does point such response/s to the combined impacts of anthropogenic activities and climate change, evidenced by warmer sea surface temperature (0.6-0.8 degC) post-2000 vis-à-vis 1980-2000 in this part of the Indian Ocean. Further, frequent, recent occurrences of harmful algal blooms in the south-west coast of India have been causes of serious economic concerns for local fisheries.

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GROUNDWATER NUTRIENTS ENTERING AN URBAN WETLAND FRINGING NEWPORT BAY, CA

Urban wetlands may play an important role in intercepting nutrients originating in their watersheds from runoff or from landscaped areas that are irrigated and fertilized. In coastal southern California, groundwater flows from irrigated land continue throughout the dry summer months, delivering fertilizer nutrients to wetlands. We measured nitrate (NO_3^-) and phosphate (PO_4^{3-}) concentrations seeping into Newport Valley Wetland, which discharges water year-round into eutrophic Upper Newport Bay, California. We sampled groundwater from 11 ca. 1-m deep seepage wells placed around the perimeter of the wetland biweekly from June 2012 to May 2013; 7 additional wells did not yield sufficient water for analysis. At the same time, we sampled dry-weather water discharges from the wetland into the Bay. Nitrate and PO_4^{3-} in seepage water was spatially and temporally variable, with high PO_4^{3-} concentrations found adjacent to a residential development, and high NO_3^- concentrations found adjacent to a golf course. The highest nutrient concentrations were found in the winter months. Phosphate concentrations in the water discharging to the Bay were lower (5.1 μmol L^{-1}) than the mean seepage water concentration (9.7 μmol L^{-1}), suggesting that groundwater phosphate was adsorbed or transformed into organic forms within the wetland. In contrast, NO_3^- concentrations in the discharge water (8.8 μmol L^{-1}) were higher than mean seepage water concentrations (3.8 μmol L^{-1}). Our results show that groundwater NO_3^- and PO_4^{3-} concentrations in urban areas are spatially variable and that wetlands are important sites for nutrient transformation, but not always mitigation.

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CHANGES IN BIODIVERSITY AND ABUNDANCE OF EELGRASS BED COMMUNITY IN NORTHERN JAPAN WITH THE 2011 TOHOKU EARTHQUAKE AND TSUNAMI

The coastal areas of northeastern Japan were heavily damaged by the mega-earthquake and tsunami on March 11th, 2011. To assess their impacts and to evaluate the resilience of coastal ecosystem including seagrass beds, we are currently carrying out long-term field monitoring of species diversity and abundance of seagrass and associated-animal communities using the same methods as those conducted before the tsunami. We are also analyzing genetic structures of eelgrass Zostera marina using microsatellite markers to examine changes in its genetic diversity and to understand recovery process of damaged seagrass beds. The post-tsunami monitoring of eelgrass beds was undertaken in 2012 at several bays along Sanriku Coast of northeastern Japan where the maximum height of the tsunami exceeded 10 m. Although the seagrass species composition did not change before and after the tsunami, area and coverage of seagrass decreased drastically in major beds located at the innermost part of each bay. In contrast, small seagrass beds at sides of the bays survived better. Abundance and species richness of epifauna decreased greatly in beds where the tsunami disturbance was severe, whereas it did not vary significantly before and after the tsunami in less disturbed beds. The genetic diversity of each seagrass bed, and genetic relatedness among beds has not changed greatly before and after the tsunami. The germination of seedlings was generally observed even in the most severely damaged seagrass beds, which may contribute to keep genetic diversity. The results obtained currently showed that the impacts of tsunami varied greatly among different localities, and even among different depths of single site. Obtained knowledge, as well as data from ongoing longer-term monitoring will be used for evaluating which parts of coastal ecosystems are sensitive to catastrophic disturbances like tsunamis, and for examining their resilience against such catastrophic disturbances.

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PROCESSES DRIVING SHELF HYPOXIA OFF THE SOUTHERN CALIFORNIA

Organisms along the US west coast may be significantly impacted by the combined effects of decreased O2 concentration and shelf processes including but not limited to coastal upwelling. New emerging, prolonged hypoxic events are expected to occur regularly and become more concerning with their largely unknown (potentially deleterious) biological and ecological consequences. Hypoxia shelves are driven by a multitude of processes that act across a wide range of spatial and temporal scales. Together, these processes all point towards a continued decline in source water O2 throughout the eastern boundary currents that is translating to significant O2 declines on the shelf and an increase in the frequency and duration of extreme hypoxic events. In this talk, exemplary processes involving the O2 variability or driving shelf hypoxia off the southern California are presented covering from the largest, longest to the smallest, local scales – interannual climate events, upwelling/relaxation variability, tide- and wind-induced short-term events.

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HYDROMEDUSAE IN THE SURF ZONE OF A SUBTROPICAL SANDY BEACH (PONTAL DO SUL, SOUTHERN BRAZIL)

Sandy beaches are very productive areas and their surf zones are considered important nursery grounds for many invertebrate and fish species. Most of the studies on zooplankton in these environments are mainly focused on crustaceans and very little is known about the hydromedusae. In this study, we analyzed the temporal variation of the composition and density of hydromedusae in relation to temperature and salinity between August 2012 and January 2013 in a sector of Pontal do Sul Beach, Southern Brazil. Samples were taken fortnightly in the surf zone by using a zooplankton cylindrical-conic net (0.5 m mouth and 300 μm mesh size) equipped with a flowmeter for volume estimates. Data on salinity, temperature, direction and velocity of the longshore currents and winds were included. The temperature data showed a significant seasonal variability with a minimum of 19.5 °C for the winter and a maximum of 29 °C for the summer, while salinity ranged between 30 to 36. All together, a total of 14 taxa of hydromedusae was found. The most important species in terms of frequency and abundance were the holoplanktonic Liriope tetraphylla and the meroplanktonic Obelia spp. The first one was more important during the winter, representing 90% of the hydromedusae, and the second was especially abundant during the summer representing 50% of the composition. The highest densities were recorded for winter (596 ind.m-3) e for the summer (747 ind.m-3). Surprisingly, the lowest values were observed during the spring, with an average of 2 org. m-3. The holoplanktonic species L. tetraphylla is usually very abundant all year round in southern coastal waters of Brazil. However, summer conditions as higher temperature and salinity values, may increase the reproduction of meroplanktonic species, favoring the release of benthic polyps, what would explain the dominance of Obelia spp. during the warmest period of this study.

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VIBRIO CHOLERAE ABUNDANCE AND DIVERSITY IS INFLUENCED BY ENVIRONMENTAL FACTORS IN MOBILE BAY, ALABAMA

Vibrio cholerae, the cause the disease cholera and lesser forms of gastrointestinal illness, is found in coastal and estuarine environments worldwide. This study focused on the ecology of V. cholerae in Mobile Bay, AL due to an increase of V. cholerae related gastrointestinal illnesses and a general lack of information regarding V. cholerae ecology in the northern Gulf of Mexico. Over one year, bi-montly samples were collected from water, sediment and oysters at three locations within the Bay, and V. cholerae was enumerated using most probable number (MPN)-PCR technique. Environmental parameters were measured at each site for each sampling date. Pulsed field gel electrophoresis (PFGE) was performed on 50 isolates from two sites during warm temperatures (23°C) and colder temperatures (11°) to characterize the diversity of V. cholerae. In the water column, the abundance of V. cholerae was negatively correlated with salinity and positively correlated with chl a. Abundances in sediment were also negatively correlated with salinity, but positively correlated with pH. V. cholerae abundance in oysters was positively correlated with pH and chl a. The abundance of V. cholerae in oysters positively correlated with abundances in sediment and water. Diversity of V. cholerae isolates differed between sites, with 46% of the isolates at one site clustering at >80% similarity, while only 16% of isolates at the other site had >80% similarity. Diversity the second site decreased as temperatures increased, with 52% of isolates clustering at >80% similarity when temperatures were 23°C. V. cholerae is present year round in water, oyster, and sediment in Mobile Bay, but the abundance and diversity of the populations are affected by environmental conditions.

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NUTRIENT SIGNATURES FROM AQUACULTURE OUTFLOWS IMPACTING CORAL REEF WATERS IN THE SPERMONDE ARCHIPELAGO, SOUTH SULAWESI, INDONESIA

One of the biggest threats to coral reef ecosystems (Spermonde Archipelago) in the west coast of South Sulawesi province Indonesia, is high nutrient discharges from aquaculture- and land-based material transports. Rivers along the west coast of South Sulawesi play an important role in mobilizing the land-based nutrients to the Spermonde waters, impacting the health of coral reefs. However, scientific investigation on the nature of nutrient inputs to the Spermonde coastal waters is still lacking, and the effects on adjacent coral reef ecosystems are still not well studied. This study aimed to comprehensively examine the characteristics of dissolved inorganic nutrients (i.e. NO3-N, NO2-N, NH3-N, PO4-P, silicate) and microalgae (diatom/dinoflagellate) composition from four large rivers feeding the coastal area to the edge of Spermonde shelf. The preliminary results show that the Spermonde inshore waters affected by land-based nutrient supplies is characterized by high and varied concentration of nutrients (up to seven folds of those of offshore waters), which bring about changing composition of micro (diatom/dinoflagellate) and macro-algae domination.

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POLLINATOR ACTIVITY AS A BIOTIC CONTROL OF RANGE EXPANSION IN THE BLACK MANGROVE, *AVICENNIA GERMINANS*

For species undergoing range expansion, reproduction and mating systems of leading edge populations determine the rate of expansion and future genetic structure. As such, animal pollinators may exert control over future flowering plant distributions by determining rates of outcrossing, selfing, and overall reproduction. The black mangrove, *Avicennia germinans*, is currently expanding its range northward in Florida. Its flowers attract many insect taxa, but how much *A. germinans* depends on them for pollination, and whether there is effective pollination at both the leading range edge and the range interior, is unknown. In this study, pollen limitation and self-compatibility experiments were conducted during the flowering season of 2013 at two sites – one central to the eastern Florida *A. germinans* distribution, and one at the distribution's northern edge – to determine the mating system and to detect differences in pollinator effectiveness between sites. In these experiments, *A. germinans* flowers were either bagged to exclude pollinators, emasculated to prevent self-pollination within the same flower, or hand-pollinated with supplemental outcrossed pollen. In addition, the identities and frequencies of insect floral visitors were recorded at six sites spread across 250 km of Florida's east coast. The experiments revealed that *A. germinans* depends on pollinators to set fruit. Supplemental pollen significantly increased fruit set at both sites, indicating pollen limitation; however, this effect was stronger at the northern site. This pollen limitation-site interaction may have been caused by differences in insect visitation, which decreased at higher latitudes. These latitudinal patterns of pollinator frequency and effectiveness may limit *A. germinans*' northward range expansion, and must be considered in predictions of its future distribution.

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INFLUENCE OF LOCAL FOREST DIVERSITY ON DECOMPOSITION OF MANGROVE LEAF LITTER AND SEDIMENT QUALITY

The relationship between biodiversity and ecosystem function is still controversial and has not been tested in mangrove ecosystems, which have generally low diversity at all spatial scales but high level of productivity. Mangroves are accorded high ecological importance due to their role as feeding and nursery area of commercially important fish and invertebrates. Different mangrove species produce different quality of organic matter (e.g. different C/N ratios) but how the organic matter is influenced by tree species in a mangrove forest is poorly understood. The decomposition study was conducted to test the hypothesis that the leaves in a mixed mangrove forest decompose fast and produce good quality of organic matter in terms of its C/N ratio in the mangrove leaf litter and sediment. A decomposition study was done at three different locations in southeast Queensland, Australia, each with three different local mangrove plant compositions (mixed stand of *Rhizophora stylosa* (RS) and *Avicennia marina* (AM), and pure stands of the two species) during the dry and wet seasons. The decomposition rate and sediment organic content during the wet season was significantly higher than those in the dry season. The decomposition rate of AM leaves in the mixed RS+AM forest was significantly higher than in the AM forest, while the decomposition rate of RS leaves in the RS forest was significantly higher compared to that in the mixed RS+AM forest, but this pattern was not consistent among locations. Sediment organic content in the RS forest was significantly higher compared to mixed RS+AM forest and AM forest. Sediment C/N ratio during the wet season was significantly lower than that in the dry season. Sediment C/N ratio in the mixed RS+AM forest was significantly lower than RS and AM forest. Possible mechanisms behind this pattern include differences in habitat composition and structure as well as leaching of soluble organic compounds.

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YEAR-ROUND SPAWNING OF THE MARKET SQUID, *DORYTEUTHIS OPALESCENS*, AND ASSOCIATED CRITICAL HABITAT ALONG AN UPWELLING MARGIN

Market squid, *Doryteuthis opalescens*, are the basis for the most valuable fishery in California. *D. opalescens* is an important forage species for sustaining federally protected marine tetrapod populations, and a key ecological link in the nearshore ecosystem of the California Current System. Enigmatic and ephemeral, populations of squid can prove notoriously difficult to sample and have led to an inadequate understanding of this semelparous species and their spawning behavior. Prior hypotheses to explain patterns observed in fishery-dependent data suggests that market squid (1) could migrate between a northern and southern populations, (2) could migrate between deep (≥ 100 m) and shallow populations (< 100 m), and (3) could reproduce continually in a conveyor-belt type behavior. Here we conducted the first known high-frequency observational study of a squid spawning ground at La Jolla, CA. We collected embryo capsules representative of 18 cohorts from Aug 2011 through June 2013 and have evidence that these numbers are a significant underestimate of the actual number of spawning cohorts. Further, mapping the extent of embryo beds (egg beds) five times, and surveying the continental slope twice (100-400 m depth) provided evidence that market squid restrict their spawning to the continental shelf (<100 m depth) spawning over a variety of habitats including sand, submarine canyon walls, and kelp. Our results strongly support that squid reproduction is continuous throughout the year. In addition, these results suggest that a bi-weekly timescale may be the most important frequency for study of squid spawning behavior. Further, these results also suggest that squid have site fidelity or have cues linking them to specific geographic spawning areas. Future research should focus on identifying these areas and assessment of potential unknown threats including those associated with our changing climate and from benthic disturbance caused by fishing.

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MACRO- AND MESO-TIDAL WETLAND RESTORATION IN CANADA'S MARITIME PROVINCES

Tidal wetland restoration is in its infancy in Canada's Maritime Provinces. Tidal wetland restoration projects have mostly been opportunistic in nature, or required by legislation. Restoration projects have been undertaken in all three Provinces, with the majority of projects in the Bay of Fundy, the area of greatest historical loss (80%). The unique hydrological and sediment conditions experienced in the Bay, combined with the historical significance of these marshes, importance for migratory and endangered species, and as a significant component of the Gulf of Maine ecosystem have served to focus restoration efforts on these marshes. Projects with the primary goal of restoring tidal wetlands have only been undertaken since 2005, and of those projects, few have involved long-term comprehensive monitoring programs. For most of these projects, restoration efforts have focused on the reduction or elimination of the primary restriction to hydrology (dyke or causeway) and have relied on natural processes to restore the natural flora and fauna. This poster highlights the research activities, partnerships, and legislative measures leading to the success of these projects. The focus is on the 8 tidal wetland restoration projects in Nova Scotia that are using the GPAC Regional Monitoring Program in order to illustrate some of the lessons learned regarding the ecological condition of Nova Scotia tidal wetlands and their response to restoration efforts.

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ESTUARINE WATER QUALITY MONITORING IN NORTHEASTERN US NATIONAL PARKS: INTEGRATION AT LOCAL AND REGIONAL SCALES

Estuaries in National Parks in the northeastern US are severely threatened by nutrient enrichment. The Northeast Coastal and Barrier Network (NCBN) of the National Park Service includes six parks from Massachusetts to Virginia with significant estuarine resources. Water quality monitoring began at some parks in 2003, and biennial monitoring began regionally in 2006. Water quality indicators (dissolved oxygen, chlorophyll, turbidity, light attenuation) are monitored during a four-week summer index period at a hierarchy of spatial and temporal scales: within each park, a spatial survey is conducted once during the index period following a probability design; this survey is supplemented with weekly measurements at a subset of sites and continuous monitoring at a single reference site. We evaluated park-specific data collected from 2003 through 2011 to determine the mean condition of park estuaries, the percent of estuarine area exceeding thresholds, and spatial and temporal trends. NCBN estuarine monitoring was developed to be compatible with coastal water-quality monitoring programs implemented by the US EPA; therefore, we also examined water quality in NCBN estuaries in the context of northeastern coastal condition. Finally, we used multiple regression to analyze park water quality in relation to watershed nitrogen inputs and land-use stressors on a regional scale (MA to VA). Results show expected latitudinal gradients in water quality that mirror the distribution of coastal population density, but also reveal poorer condition in some park estuaries than in adjacent coastal waters. Regional patterns of chlorophyll concentration depended significantly on nitrogen load estimates, the distance to sources of flushing, and salinity (R^2=0.49), while water-column light attenuation depended on turbidity, nitrogen load estimates, and temperature (R^2=0.75). Such data integration will help park managers identify strategies to maintain or improve estuarine water quality.

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HITCHHIKERS GUIDE TO SHIPPING – VESSEL TRAFFIC AND THEIR NONINDIGENOUS SPECIES MANAGEMENT PRACTICES AT NORTHERN CALIFORNIA PORTS

Nonindigenous species (NIS) are organisms introduced through human activities to an area where they do not naturally or historically occur. Once established, NIS can have ecological, economic, and human health impacts on the receiving environment. The coastal waters of California are some of the most invaded areas of North America, roughly 89% of western North America's currently established marine NIS were first documented in California. In coastal environments, the commercial shipping pathway has contributed up to 79.5% of NIS introductions to North America and 81% in California. Commercial vessels transport organisms through two primary vectors: ballast water and biofouling. The California State Lands Commission's Marine Invasive Species Program (MISP) is responsible for preventing or minimizing the release of NIS from vessels that are 300 gross registered tons and above. In order to assess the likelihood for vessels to introduce NIS into California waters and/or spread NIS to other areas, an examination and analysis of vessels' NIS management practices and their previous and subsequent ports of call was conducted for the ten recognized commercial port zones in northern California. This study examines the ballast water and biofouling management practices of the vessels arriving in northern California. For example, 17.8% of these vessel arrivals discharged ballast water into California waters. Understanding ballast water and biofouling management patterns and the movement of vessels can inform risk management strategies to decrease the introduction, establishment, and spread of NIS.

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INTEGRATING SOCIO-ECOLOGICAL RESEARCH AND COLLABORATIVE LEARNING TO INCREASE MARSH AND COMMUNITY RESILIENCE TO SEA-LEVEL RISE

This project highlights how sentinel-like data can be incorporated into a broader socio-ecological framework. Coastal habitats and communities are facing widespread degradation and losses of coastal marshes in the Mid-Atlantic region due to sea-level rise and other stressors. In this project, we are using the coastal peninsula of Deal Island, MD as a case study of a community with a strong coastal heritage that is facing ecological and social stresses from sea-level rise. We are using collaborative learning and integrated anthropological, economic, and ecological investigations to better understand and improve the resilience of this socio-ecological system. The goals of this project are to: 1) Establish a continuing collaboration among local community, state and federal agency, academic, and non-governmental organization stakeholders working towards the resilience of the marshes and local communities of the Deal Island peninsula; 2) Develop and test a broadly transferable process of engaging stakeholders to optimize and implement strategies that restore and conserve marshes and local communities; and 3) Better understand the provision of socio-ecological services by marsh systems and decision-making processes within the stakeholder community. We are conducting three focused Collaborative Research Projects on the topics of marsh restoration, flooding, and heritage. The restoration of ditch-drained marshes is being used as a case study within these Collaborative Research Projects. Through this project, we are establishing a partnership to address sea-level rise in this community as well as improve strategies for adaptation elsewhere. The methodologies developed through this project hold promise to facilitate the implementation of marsh conservation and restoration and community adaptation strategies throughout coastal regions. In this presentation we will discuss our preliminary results and the challenges and accomplishments of the first year of this project.

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ROLE OF PLANKTON BLOOMS IN MITIGATING HYPOXIA THE COLUMBIA RIVER ESTUARY

The Columbia River estuary is a river-dominated salt wedge estuary that exhibits strong seasonality in river discharge and degree of salt water intrusion. During summer and fall, low discharge conditions result in higher salinity intrusion and the concomitant transport of low oxygen water masses into the estuary that originate from the continental shelf. These conditions pose a threat to endangered salmon that use the estuary as a habitat and migration corridor. Here we report evidence suggesting that an ecological mitigating factor of low oxygen conditions in the estuary is the phenomenon of massive blooms of the cilitate Mesodinium rubrum that often co-occur with low oxygen events in the estuary. We show physical, chemical, and biological data from high resolution in situ sensors and from research cruises conducted in 2011 and 2012 that support the notion that M. rubrum blooms are hotspots of biogeochemical activity that alter conditions at the ecosystem scale, and to the extent that hypoxia is significantly alleviated. We highlight the unique autecology of the organism that enables it to bloom in the rapidly flushed Columbia River estuary without negative effects (i.e. hypoxia) typically associated with bloom decay.

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BIOMASS TRANSFER SUBSIDIZES NITROGEN TO OFFSHORE FOOD WEBS

We evaluated the potential contribution of allochthonous biomass subsidies to the upper trophic levels of offshore food webs in the northeastern Gulf of Mexico (GOM). We made this evaluation considering nitrogen, an essential and often limiting nutrient in coastal ecosystems, to estimate the potential production of within-ecosystem biomass relative

to the known import of biomass from an adjacent seagrass-dominated ecosystem. When adjusted for trophic transfer efficiency, we found the biomass subsidy from a single species (pinfish, Lagodon rhomboides) from nearshore seagrass habitat to the offshore GOM to be greater than the amount of nitrogen exported by two major rivers and local submarine ground water discharge. Our calculations show that seagrass-derived biomass accounts for approximately 25% of the total potential production in the northeastern GOM. This estimate is in agreement with a previous study that found 18.5–25% of the biomass in a predatory reef fish was derived from seagrass biomass inputs. These results indicate that all of the sources we consider account for the majority of the nitrogen available to the food web in the northeastern GOM. Our approach could be adapted to other coupled ecosystems to determine the relative importance of biomass subsidies to coastal ocean food webs.

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A STUDY OF CONTINUOUS CURRENTS AND DISSOLVED OXYGEN LEVELS IN CORPUS CHRISTI BAY

Seasonal hypoxia in Corpus Christi Bay, TX has been observed every summer since its discovery in 1988. Eutrophication does not appear to be the main factor in this hypoxia as nutrient levels in Corpus Christi Bay are generally. Hypoxia has been shown to occur when the water column is salinity-stratified. Current profiles were collected at 5 sites in Corpus Christi Bay to discover the factors contributing to stratification. The water column displayed two distinct layers defined by current speed, direction and echo level. The bottom one meter was acoustically clearer than the upper column and the bottom current speed varied with wind speed. Current speeds in the upper layer were consistent bay-wide and became more acoustically opaque with depth. The shear causes by current velocity differences between the top and bottom layers could be exacerbating the stratification already due to salinity differences.

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SEDIMENT TOTAL ORGANIC CARBON: IS IT TIME TO PULL THE PLUG ON THIS INDICATOR?

Total organic carbon (TOC) content of sediments has been used as an indicator of benthic community condition during multiple cycles of the EPA National Coastal Assessment (NCA). Because percent TOC is generally positively correlated with sediment percent fines, previous analyses have shown that an uncorrected TOC index will substantially overestimate potentially impacted sites. Analysis of NCA data indicates that biogeographic regions differ significantly in the relation of TOC to grain size. Within a region, individual estuaries also differ significantly in the regression slopes of TOC and grain size, and estuary classification has so far failed to provide insight into the drivers of this variation. Within an individual estuary, the spatial variation in depositional versus erosional conditions may drive the relationship. Analysis of studies conducted along organic enrichment gradients found varied responses of benthic species richness to TOC, ranging from strongly negative to positive. Given the multiple scales and sources of variation, we conclude that TOC is currently not a useful indicator of marine benthic condition in regional scale assessments.

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INVESTING IN THE WORKFORCE THROUGH MENTORING

The term mentor is often used synonymously with a faculty adviser in academic settings, but a mentorship is also a career development relationship in which more experienced senior colleagues share their knowledge and experience with mentees. Having the advice and guidance of an experienced colleague can help employees plan their careers and manage challenging situations. Mentoring can involve orienting new hires to the landscape, values, and culture of their work environment; working with staff to establish career goals and develop requisite skill sets; or providing employees with situational counseling. Whether formal or informal, mentoring fosters growth and development. Here, we will present examples of mentorships, including internships, student services contractor opportunities, postdoctoral fellowships, and employee pilot mentoring efforts at a national research laboratory. In addition to building professional relationships, these programs are designed to benefit the mentee by introducing them to the research culture within a federal agency, and providing experiences to broaden expertise and future job opportunities. Mentors benefit through exposure to emerging research and subsequent contributions for recruitment and retention of top talent. Overall, these mentoring efforts represent an important cornerstone of workforce engagement that benefits the national research laboratory as a whole.

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VARIABILITY AND CONVERGENCE IN BENTHIC COMMUNITIES IN CREATED SALTMARSHES TRANSITIONING INTO MANGROVE HABITATS

Wetland creation, enhancement, and restoration activities are commonly implemented to compensate for wetland loss or degradation in coastal ecosystems. Although assessments of structural condition are commonly used to monitor habitat restoration effectiveness, functional equivalence in restored and created wetland habitats is often poorly understood. In estuarine habitats, variations in habitat quality are expected to produce relatively predictable variations in the structure and composition of macrobenthic communities, and it is generally assumed that the associated ecosystem functions of the community change as well. We evaluated the developmental trajectory of benthic ecosystem function in created tidal wetland habitats of different ages (range: 2-20 years) in the Tampa Bay region by measuring the development of wetland soil characteristics and secondary production of the macrobenthic community. Community properties of these created wetlands were compared with natural reference wetlands. Across the age chronosequence, the created wetlands transitioned from planted salt marshes to mangrove forests. Here, we present results quantifying the impact of time-since-creation upon ecosystem properties and processes, and discuss the relevance of macrobenthic community measurements for evaluating wetland functional equivalence. These data will be used to quantify how habitat and water quality restoration in coastal areas can improve production of valued ecosystem attributes such as biodiversity and fishery production. Findings will be incorporated into empirical models to evaluate alternative future scenarios across a changing landscape as part of the U.S. Environmental Protection Agency's Tampa Bay Ecosystem Services Demonstration Project.

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SALTWATER INTRUSION INTO TIDAL FRESHWATER MARSHES ALTERS GREENHOUSE GAS PRODUCTION AND EMISSIONS TO THE ATMOSPHERE

Environmental perturbations in wetlands affect the integrated plant-microbial-soil system, causing biogeochemical responses that can manifest at local to global scales. The objective of this study was to determine how saltwater intrusion affects carbon mineralization and greenhouse gas production and emissions. Working with tidal freshwater marsh soils that had experienced roughly 3.5 years of in situ saltwater additions, we quantified changes in soil properties, measured extracellular enzyme activity associated with organic matter breakdown, and determined potential rates of anaerobic carbon dioxide (CO_2) and methane (CH_4) production. Soils from the field plots treated with brackish water had lower carbon content and higher C:N ratios than soils from freshwater plots, indicating that saltwater intrusion reduced carbon availability and increased organic matter recalcitrance. This was reflected in reduced activities of enzymes associated with the hydrolysis of cellulose and the oxidation of lignin, leading to reduced rates of soil CO_2 and CH_4 production. The effects of long-term saltwater additions contrasted with the effects of short-term exposure to brackish water during three-day laboratory incubations, which increased rates of CO_2 production but lowered rates of CH_4 production. Collectively, our data suggest that the long-term effect of saltwater intrusion on soil CO_2 production is indirect, mediated through the effects of elevated salinity on the quantity and quality of autochthonous organic matter inputs to the soil. In contrast, salinity, organic matter content, and enzyme activities directly influence CH_4 production. Our analyses demonstrate that saltwater intrusion into tidal freshwater marshes affects the entire process of carbon mineralization, from the availability of organic carbon through its terminal metabolism to CO_2 and/or CH_4, and ultimately influences greenhouse gas exchanges with the atmosphere.

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CHARACTERIZING THE PRISTINE OYSTER REEF COMMUNITY OF SABINE LAKE ESTUARY RELATIVE TO SURROUNDING MARSH EDGE AND NON-VEGETATED BOTTOM HABITATS

Sabine Lake is an approximately 360 km2 estuary on the Texas-Louisiana border formed by the union of the Neches and Sabine Rivers. With nearly 200,000 acres of marshes that surround the estuary, it is one of the largest ecosystems in Texas. This estuary is unique in terms of its large oyster reef complex with no record of commercial harvest as far back as the 1960's. It is likely one of the largest remaining un-fished oyster reefs in the United States. The overarching goal of this research project was to describe the oyster population

structure and community composition of finfishes and invertebrates on this naturally functioning reef system, along with nearby non-vegetated bottom and marsh edge habitats. We found that temperature and dissolved oxygen were the two primary environmental parameters determining live oyster abundance and growth in Sabine Lake from fall 2011 through spring 2012. The oyster reef and nonvegetated deep habitats had significantly fewer fish and crustacean densities than the marsh edge habitat. Although the largest abundances of transient and resident fishes were both found within the marsh edge habitat, our community analysis provides evidence that the subtidal oyster reef is a critical habitat for various estuarine species. This study may serve as a baseline analysis for a subtidal unfished oyster reef community, and would have clear management implications if the reef was opened to commercial fishing in the future.

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EFFECTS OF INTEGRATED STORMWATER MANAGEMENT AND STREAM ENGINEERING ON WATERSHED NITROGEN RETENTION

Restoring urban infrastructure and managing the N cycle are major challenges in urban ecosystems. We investigated whether stormwater best management practices (BMPs) integrated into restored and degraded urban stream networks can influence removal of N pollution. We hypothesized that stormwater BMPs are greater "hot spots" for N removal through denitrification than connected floodplain areas because they have ample organic carbon, low DO levels, and high residence time. We tested this hypothesis by comparing N retention metrics in 2 urban stream networks with stormwater BMPs and a forested reference watershed at the Baltimore Long-Term Ecological Research site. We used a combination of: 1) stream reach scale mass balances of N conducted monthly for 2 years across streamflow (n=250), 2) in-stream tracer injection studies to measure nitrate uptake and groundwater inputs (n=6), and 3) 15N in situ push-pull tracer experiments to measure seasonal N removal via denitrification in stormwater BMPs and floodplain features (n=72). The stormwater BMPs consisted of inline wetlands installed below a storm drain outfall at Spring Branch and a wetland and wet pond configured in an oxbow to receive water during high flow events at Gwynns Run. As hypothesized, total dissolved nitrogen (TDN) concentrations declined significantly as water traveled through stormwater BMPs; TDN concentrations decreased from 1.26 mg/L at Spring Branch and 1.68 mg/L at Gwynns Run. Contrary to our hypothesis, mean TDN retention at Spring Branch was higher in a stream reach with connected floodplains, 2.01 ± 0.77 kg/day, than in the stormwater BMPs, 0.053 ± 0.025 kg/day. Similarly, at Gwynns Run, mean TDN retention (and export) were 3 orders of magnitude higher in the stream reaches, 2.00 ± 1.6 kg/day, than in the stormwater BMPs, 0.005 ± 0.597 kg/day. Surprisingly, mean 15N *in situ* denitrification rates were not significantly different between BMPs and floodplain areas and were high in both feature types.

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THE ENIGMATIC NITROGEN CYCLE: DISENTANGLING SEDIMENT N_2 FLUXES IN A TEMPERATE ESTUARY

Coastal systems are acutely vulnerable to climate change and nitrogen pollution, causing eutrophication and resulting in increased hypoxia, loss of seagrasses, and macroalgae growth. The impacts of eutrophication are fundamentally altering the nitrogen cycle by reducing the buffering capacity for excess nitrogen, and these alterations are not well constrained. Net measurements of N_2 gas fluxes conceal the complexity of co-occurring sediment processes, such as sediment N fixation and denitrification. We measured these processes, along with dissimilatory nitrate reduction to ammonium (DNRA), directly in a one-week, continuous-flow incubation of intact sediments from Waquoit Bay, MA. Nitrogen fixation occurred simultaneously with DNRA and denitrification. Evidence for nitrogen fixation included net $^{28}N_2$ and $^{30}N_2$ uptake, $^{15}NH_4^+$ production, $^{15}N_{organic}$ production, and *nifH* expression. N fixation rates in the $^{30}N_2$-amended cores ranged from 82±15 to 325±51 μM m^{-2} hr^{-1}, while the maximum denitrification rate from the $^{15}NO_3^-$ amended cores was 41 μM m^{-2} hr^{-1}. However, N fixation rates calculated from $^{15}NO_3^-$ amendments were at least 2x less than measured fixation from $^{30}N_2$ amendments. DNRA outcompeted denitrification for nitrate until oxygen concentrations in the overlying water decreased to ~120 uM. Potential denitrification rates from the $^{15}NO_3^-$ treatments did not exceed fixation in the $^{30}N_2$ cores, suggesting that denitrification may be underestimated even by direct measurements. Thus, these findings illustrate that underestimation of nitrogen fixation in sediments also leads to underestimation of denitrification. These unexpected results highlight the dynamic nature of sediment N cycling and suggest quantifying individual processes is essential to fully understand anthropogenic impacts of human activities on coastal nutrient cycling.

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COASTAL RESILIENCE VENTURA: CLIMATE ADAPTATION ON AN URBAN COAST

Climate change is altering California's shores by way of multiple stressors including sea level rise, increases in erosion, inundation from storm surge, increasingly intermittent and intense precipitation and flooding, and saline intrusion into drinking- and agricultural-water supplies. These climate stressors converge in coastal, riverine, and estuarine systems, and will affect biological and agricultural resources as well as municipalities. Communities will have to adapt to these changes, and although there are a range of adaptation approaches from which decision-makers will choose, nature holds some of the best and most practical solutions. The Nature Conservancy's Coastal Resilience approach aims to provide tools and information to better inform decision-making with a primary goal of identifying vulnerable human and natural communities and enabling adaptation solutions, emphasizing the important role of ecosystems. This approach has been tested in a variety of geographies (see www.coastalresilience.org for more information), including southern California. Coastal Resilience Ventura is the first application that addresses a mix of climate stressors (sea level rise, river flooding and saline intrusion) on a diverse array of land uses (development, agriculture and natural), and which is partner-driven at all stages. This presentation will discuss the importance of collaborative decision-support tool development and strategy evaluation for coastal areas threatened by climate change and how a regional approach to climate change planning can be scaled-up to impact state and federal policy.

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BUILDING CAPACITY TO ADDRESS CLIMATE CHANGE IN CALIFORNIA

The University of Southern California Sea Grant Program is an "Urban Ocean" program, focusing on issues arising out of the necessity of managing people and resources in an intensely developed coastline. Coastal communities in California are anticipating a climate change scenario in which temperatures will warm significantly during the 21st century, and thus expect an increase in the frequency, magnitude and duration of heat waves and sea level rise extremes. Recognizing the challenges facing coastal urban communities due to a changing climate, USC Sea Grant has developed a robust climate change program focused on funding climate science research, developing outreach products and education tools to understand the impacts of climate change, and working directly with local, regional and state entities along the California coastline to help coastal managers adapt to the imminent impacts of climate change. Building capacity among coastal managers and planners is critical to this effort. According to a USC Sea Grant needs assessment of over 600 California coastal managers and policy-makers, 78 percent indicated that addressing climate change is a high priority in their jurisdiction, but over 60 percent also said they have not yet participated in any formal training on planning for climate change. USC Sea Grant has partnered with leading organizations to develop and deliver training programs to build capacity in the Los Angeles region and throughout California. In this session, we will discuss current efforts to build capacity, as well as discuss a regional effort underway in the Los Angeles region.

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IOOS CONTRIBUTIONS TO UNDERSTANDING OCEAN ACIDIFICATION: FROM REGIONAL TO NATIONAL TO GLOBAL

The U.S. Integrated Ocean Observing System (IOOS®) is partnering with NOAA's Ocean Acidification Program (OAP) and eleven Regional Associations of IOOS to optimize the nation's ability to monitor and understand ocean acidification in diverse ocean, coastal, and estuarine environments. Addressing ocean acidification as part of the IOOS system has been a focus in many of the eleven regions, with great success stories coming from diverse areas including the Pacific Northwest, the Caribbean, and the Northeast, among others. Partnerships between federal and non-federal groups have been a constant in the recipe for success, and this is enabled by the U.S. IOOS design. Moreover, new strategic efforts between all three, the IOOS program office, NOAA OAP, and specific Regional Associations, in collaboration with the NOAA Pacific Marine Environmental Laboratory are facilitating groundbreaking work on new sensor development and application for the West Coast, Alaska, and Hawaii. Included in these efforts will be testing of a new dissolved inorganic carbon analyzer, expansion of prototype aragonite saturation monitoring equipment in shellfish hatcheries, testing of new pH sensors on deepwater coastal moorings, and development of an optimal estuarine monitoring buoy system for ocean acidification.

In this presentation, we highlight the successes of this work to date as well as the new endeavors to bring these critical observations to users.

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TIME-SERIES OBSERVATIONS FOR HYPOXIA ADJACENT TO THE CHANGJIANG ESTUARY DURING SUMMER

A new kind of Trawl Resistant Bottom Mount (TRBM), which could equip ADCP, CTD and acoustic release in a lump, was used in hypoxia observation adjacent to the Changjiang estuary in 2009. Time-series data at 30-min intervals of near bottom (about 0.5m above seabed) temperature, salinity, oxygen and turbidity were obtained from some sites to study hypoxia during the period of June through September. The data obtained from B3/C2/C4 sites in 2009 reveal the occurrence of episodic subsurface hypoxic events, but no occurrence at D3 where the observing period was shorter(3rd June-31st July). The fluctuating modes of oxygen concentration are obvious different in different sites, and show some interesting results. The time of the initial hypoxic event appearing is delayed from north to south, which it was in the middle of July at B3 and at the beginning of August at C2 and at the end of August. The reason maybe contributed to the trend of the Changjiang river diluted water during the period of June through September which flow in northeast in the beginning. To study the mechanism of variability of oxygen concentration, the correlation among bottom oxygen concentration, intensity of thermocline and sea surface wind were analyzed. There is notable negative correlation between oxygen concentration and intensity of thermocline. When the velocity of wind is greater than 8m/s, it would weaken the thermocline obviously. For further study, the biochemical process, horizontal transport and tide should be considered.

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SETTING EXPECTATIONS FOR MARINE PROTECTED AREA PERFORMANCE: MATCHING POPULATION MODELS TO MONITORING DATA

An important aspect of evaluating the effectiveness of Marine Protected Areas (MPAs) is developing a clear set of expectations for responses to MPAs. The metrics for performance should have clear links to population dynamics or ecosystem health. Responses of fished populations to MPAs can be interpreted in terms of 1) the changes in size frequency distributions or 2) the change in aggregate measures such as abundance or biomass; in either case detection of a response should focus on sizes taken in the fishery. Rockfish populations in Central California MPAs have shown mixed responses in both abundance and mean size since MPA implementation in 2007. Here we assess how potential increases can be obscured in the short term by a variety of factors. We used population models parameterized for rockfish species to investigate the factors affecting short-term post-MPA dynamics. We found that positive effects of MPAs on rockfish abundance may be occluded by variability in larval recruitment or the ontogenetic migration of older fish to deeper water. The expected increase in abundance or size is also dependent on the fishing mortality rate before MPA implementation, which is largely unknown at the spatial scale of MPAs. However, even in best-case scenarios, observations made after 4-7 years would only be on the cusp of reliably beginning to detect MPA effects, particularly for long-lived species such as rockfishes.

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CONTRASTING COMMUNITY STRUCTURE, TROPHIC LINKS AND ECOSYSTEM CONNECTIVITY OF LONG VERSUS POCKET BEACHES ALONG THE CALIFORNIA'S NORTH-CENTRAL COAST

Trophic subsidies of macrophyte wrack influence the abundance and species richness of wrack-associated invertebrates and the abundance of shorebirds that feed on them on sandy beaches in southern California. We hypothesized these relationships would also be evident on north-central California beaches and used this as a conceptual framework for our baseline monitoring program in newly established MPAs. During the planning process, scientific guidance indicated that a minimum of one linear kilometer of sandy shoreline in an MPA (not necessarily contiguous) would be sufficient for meeting one of several conservation objectives for sandy beach ecosystems. As a result, north-central California MPAs include a mix of long and pocket beaches. However, little research exists on the ecology of the region's sandy beaches, and even less about the ecology of pocket beaches in general. We surveyed the seasonal abundances and taxonomic composition of macrophyte wrack and birds for a year and did a single survey of macroinvertebrate abundance and diversity on 10 beaches (six long and four pocket beaches [< 250 m long and bounded by rocky outcrops or headlands]). Half the beaches of each type were also MPAs. Kelp wrack and wrack-associated invertebrates were more abundant on pocket beaches, while total macroinvertebrate biomass and species richness were correlated with the abundance of shorebirds across all beach types. Terrestrial birds and shorebirds were associated with different beach types; terrestrial birds (including Ravens, American Crows, Black Phoebes and Brewer's Blackbirds) were more tightly linked to pocket than long beaches and shorebirds (including Sanderlings, Marbled Godwits, Willets and Western Snowy Plovers) were less frequently observed on pocket beaches. Our results suggest different ecological processes and ecosystem linkages drive community structure and habitat use of long versus pocket beaches along California's north-central coast.

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EFFECTS OF DETRITAL ENRICHMENT ON INTERTIDAL BENTHIC BIODIVERSITY AND ECOSYSTEM FUNCTION

Accumulations of drift macroalgae are a common natural disturbance affecting the biodiversity of coastal benthic communities worldwide. While the impacts of macroalgae mats on benthic biodiversity have been well documented, the effects of the resulting detritus on the benthos have not. Here, we examine how differing amounts of decomposing Ulva detritus alter biodiversity and ecosystem function of a New Zealand intertidal sandflat community. In late summer, we added high (240g m-2 dry weight (dw)), medium (120g m-2 dw) and low (60g m-2 dw) amounts of dried Ulva detritus (~ 5 mm2 pieces) to surficial sediments in replicated (n=5) 1 m2 experimental plots. These treatment levels corresponded to naturally occurring amounts of Ulva observed on sandflats during summer. At 2, 4 and 8 weeks post-addition we measured solute (nutrient and dissolved oxygen) fluxes across the sediment-water interface in light and dark benthic chambers. We also sampled for macrofauna and sediment properties. From solute fluxes we derived estimates of ecosystem function: benthic metabolism, nutrient regeneration/uptake and net primary production. Initial results demonstrated a strong impact of Ulva detritus on benthic metabolism (dark chamber O2 flux). After 2 weeks, low treatment additions had a significantly higher O2 demand than all other treatments, suggesting a stimulatory effect on benthic activity; whereas the high treatment had the lowest O2 demand, indicating inhibition. At 8 weeks, the medium and high treatments were not significantly different from the controls, however the low treatment was still significantly higher. We hope to use these data to determine how the amount of detritus regulates the structure and functioning of intertidal sandflat communities.

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INTENSIVE MOLLUSC FARMING IN COASTAL LAGOONS: IMPLICATIONS FOR BENTHIC BIOGEOCHEMISTRY

Coastal lagoons in the Mediterranean region are heavily exploited for shellfish farming, which continues to expand due to increasing seafood demand. High shellfish densities over wide surface areas impact benthic processes and water quality, especially in restricted and

chocked lagoons. Here we report results from field and laboratory experiments performed in the Sacca di Goro lagoon (Northern Adriatic Sea, Italy), one of the main producers of *Ruditapes philippinarum* in Europe. About 50% of the lagoon is exploited, with clam biomass attaining up to 10 kg m^{-2} and an average annual production of about 15-18,000 tons. We studied benthic metabolism and nitrogen and phosphorous processing in relation to animal densities under different seasonal conditions. At the typical farming densities, clams take up suspended particulate nutrients and stimulate denitrification (up to 400 μmol N_2 m^{-2} h^{-1}). Concurrently, the benthic metabolism is net heterotrophic and releases significant amounts of dissolved inorganic nitrogen (up to 4 mmol m^{-2} h^{-1}), soluble reactive phosphorous (up to 150 μmol m^{-2} h^{-1}) and the greenhouse gas N_2O (up to 1 μmol m^{-2} h^{-1}). Mesocosm experiments demonstrate that nutrient recycling by clams can stimulate opportunistic macroalgae (*Ulva* spp), enhancing growth rates and increasing chlorophylls, nitrogen and phosphorus in the thallus. These results seriously question the hypothesis that suspension-feeding bivalves act as eutrophication buffers, by promoting the removal of nutrients from the system. We argue that at high densities clams are likely transformers, rather than sinks of nitrogen and phosphorous, especially in the warmer months when nutrient regeneration rates are maximal, and other nutrient sources are much lower, e.g. due to negligible freshwater run-off.

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ENVIRONMENTAL IMPACTS ON CHESAPEAKE BAY RESULTING FROM INFILL OF THE CONOWINGO RESERVOIR

A theme of this session is that "new or increased loadings of nitrogen, phosphorus, and sediment from growth in the Chesapeake Bay watershed will be offset by loading reductions and credits generated by other sources." One new loading source that may require equivalent offsets results from scour of bottom sediments and associated nutrients from the Conowingo Reservoir. The reservoir is situated at the head of the bay, immediately downstream of the Susquehanna River watershed. Historically, the reservoir has acted as a sediment trap and has prevented substantial quantities of sediment and nutrients generated in the watershed from being discharged to the bay. The reservoir is now nearly filled to capacity, however, and substantial attention is being devoted to the potential for additional solids and nutrient loads, scoured from the reservoir, to confound the recently-enacted TMDL's. We have implemented a series of models in the watershed, in the reservoir, and in the bay to examine impacts of the reservoir filling on bay water quality. Effects of additional solids loads are short-lived and may be of little impact due to occurrence of storm loads during periods when light attenuation is not a critical component of water quality. Nutrients associated with solids linger in bottom sediments and can degrade water quality months or years after release. We calculate that nutrient loads associated with a reservoir scour event depress dissolved oxygen in the bay trench by 0.1 to 0.2 mg/L during the critical period of summer hypoxia. Chlorophyll concentration increases by 0.5 mg/m3. Increases in light attenuation during the critical period of SAV growth vary and depend on storm timing. A winter storm has negligible impact on critical light attenuation while a June storm may increase attenuation by up to 2/m for a brief period.

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SEA-LEVEL RISE IMPACTS ON SALT MARSH COMMUNITIES: THE EFFECT OF A DOMINANT PLANT SPECIES

Climate change is expected to impact coastal wetlands in a variety of ways, including sea-level rise (SLR), but the consequences of SLR for whole salt marsh communities are largely unknown. Differential species responses to SLR will likely alter competitive and facilitative interactions between plants that are important in determining salt marsh community composition. The response of dominant species to SLR may drive community change as associated species face reduced competition or facilitation. We conducted a transplant experiment to investigate whether the effect of SLR on southern California salt marsh communities is mediated by the dominant species, *Sarcocornia pacifica*. At two sites in San Diego, CA, 0.25m^2 sections of marsh were transplanted from the high mid-marsh (~1.8m NAVD88) to the same elevation, 10cm lower or 30cm lower in fall 2012. At each elevation, 0%, 50% or 100% of *S. pacifica* cover was removed to determine whether community response to elevation depends on *S. pacifica* cover. After three months, plots at lower elevations showed reduced plant productivity and altered species composition, but *S. pacifica* removal had little effect. This experiment is still in its early stages and will help us better understand the role of dominant species in determining how salt marsh communities will be affected by SLR.

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QUANTIFYING EXTERNAL NUTRIENT LOADS TO SAN FRANCISCO BAY

Nutrient loads to and concentrations in subembayments of San Francisco Bay are comparable to or greater than those in other estuaries that experience beneficial use impairment due to nutrient overenrichment. The combination of high nutrient availability and changes in environmental factors that regulate the Bay's response to nutrients has generated growing concern about whether areas of the Bay are trending toward, or may already be experiencing, nutrient-related impairment. To help inform nutrient management considerations, we estimated external nutrient loads to the Bay, evaluated how those loads vary spatially and temporally in magnitude and speciation, and assessed the relative importance of various sources. On an annual-average basis, all considered sources combined for loads of 75000 kg d-1 dissolved inorganic nitrogen and 6000 kg d-1 phosphate Bay-wide. Treated wastewater effluent from the 42 publicly-owned treatment works (POTW) that service the Bay Area's 7.2 million people contributed 34000 kg d-1 ammonium, 12000 kg d-1 nitrate, and 4000 kg d-1 phosphate. The dominant sources of N and P loads, and the form of N, varied substantially among subembayments. In southern subembayments, POTWs were the dominant N and P sources. Exchange with the coastal ocean has the potential to be a substantial net source of nutrients, but remains poorly quantified and highly uncertain. Although stormwater loads estimates developed to date are highly uncertain, in most subembayments and during most of the year stormwater nutrient loads were substantially less than POTW loads, with potential exceptions being loads to northern subembayments. The San Joaquin and Sacramento Rivers, which enter the north Bay through the Delta after draining ~40% of California, deliver approximately 90% of the Bay's freshwater inputs, and have the potential to be large and seasonally-dominant nutrient sources to northern subembayments, potentially constituting 25-30% of annual-average Bay-wide loads.

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CITIZEN SCIENCE, SMARTPHONES AND THE COLOR OF NATURAL WATERS

A widely adopted, scientific approach to assess the environmental status of water bodies is by measuring their optical properties. The color of natural waters is affected by the presence of dissolved organic matter, sediment load and phytoplankton biomass, commonly considered as water quality indicators. Color measurements of natural waters are based on multi- and hyper spectral measurements performed at sea and from space. A simpler and less costly approach for this is the use of the Forel-Ule color comparator scale. This scale has been applied globally and intensively by oceanographers and limnologists since the 19th century, offering one of the oldest oceanographic data sets. The method provides a color index between 1 and 21, from indigo blue (ocean) to dark brown (continental). Within the EC-funded project CITLOPS (Citizens' Observatory for Coast and Ocean Optical Monitoring), with its main goal to empower end-users, willing to employ community-based environmental monitoring, our aim is to digitalize the colors of the Forel-Ule scale to establish the color of natural waters through smartphone imaging. A specific "ocean color" smartphone application (App) was developed by means of colorimetric experiments in the laboratory. Then, the validation and calibration of the digital scale were carried out with radiometric and Forel-ule measurements as well as digital images acquired in the North Sea and estuaries across the Netherlands. Preliminary results show satisfactory relationships between the classic and the digital Forel-Ule scale, and indicate that the developed 'App' could be a valuable tool to gather data useful for scientists and policy makers, provided good calibration exercises are carried out in the future. The distribution of this 'App' would be especially useful for water quality managers in third-world countries, as it represents a low-cost and easy-to-use tool for the assessment of water color changes in estuarine and coastal areas.

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DEMOGRAPHIC IMPACTS OF CLIMATE CHANGE ON TIDAL MARSH BIRDS AND THEIR HABITAT: A DECISION SUPPORT TOOL FOR TIDAL WETLAND RESTORATION AND MANAGEMENT IN SAN FRANCISCO BAY

Tidal marsh habitat is of great concern due to: severe loss and degradation of habitat; endemic species, many of them threatened or endangered, that depend on this habitat; and vulnerability of these species to climate change. Unprecedented efforts to restore tidal marsh habitat in San Francisco Bay are now underway or will soon be implemented. However, the anticipated impacts of climate change and other stressors need to be better understood in order to prioritize the investment of resources in restoration and other activities. To provide specific management guidance to maximize long-term population viability within the context of accelerating climate change and to guide restoration planning and implementation, we have developed a Decision Support Tool (DST), Future San Francisco Bay Tidal Marshes. The DST builds on spatial modeling of projected changes in tidal wetland habitat extent and habitat characteristics under multiple scenarios. For four key marshbird species we have projected habitat suitability at present and over the next 100 years in relation to projected sea-level rise, sediment concentration, and salinity. In addition, we have developed population-dynamic models, both deterministic and stochastic, for each of the species. The

models allow us to project effects of changes in temperature, precipitation, and extreme tides (due to sea-level rise and severe storms) on population viability. We describe a spatially-explicit demographic model for SF Bay tidal marshbirds that projects population change and future viability in relation to climate change, changes in land-use due to restoration of tidal marsh habitat, and other management actions, such as predator control and creation of refugia. We demonstrate how the DST can be used to provide information on how restoration can increase population resilience, and can assist vulnerability assessment and adaption planning by comparing impacts of climate change on competing restoration or management plans.

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HYDROLOGY OF A PROTOTYPICAL, SMALL BAR-BUILT ESTUARY: SCOTT CREEK (CA)

The morphodynamics of seasonally closed bar-built estuaries interact with seasonal river flow to determine the estuarine hydrology. In particular, our interest is in estuarine stratification and water residence, which is a primary determinant of the physical, chemical, and biological character of the lagoon habitat, including issues like water quality, community dynamics, and ecosystem metabolism. The aim of our study is to evaluate the effects of estuary inlet closure on the hydrological state of Scott Creek as a prototypical example of small bar-built estuaries in California and comparable regions elsewhere. Data on water level, temperature, salinity, pH, and dissolved oxygen are available from time-series sensors. More recent novel data collection will be combined with an extensive historic time-series data set to investigate patterns of mouth closure and resulting estuarine hydrology. This study is motivated by the need to understand the hydrological foundation of the valuable habitat found in these small estuaries for juvenile salmonid growth and survival. Specifically, we hope to improve and guide human activities and management of these systems towards scenarios with optimal environmental value. Human activities include streamflow management, road-bridge design, and mouth management. Additional recent motivation is derived from interest in redesigning existing Highway 1 bridges over Scott Creek and several other coastal creeks. We will present an analysis of data from Scott Creek and offer a general conceptual model of the link from streamflow and ocean conditions to estuary state, hydrological conditions, and juvenile salmonid habitat with a view to identifying where human activities alter these linkages.

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THREE CRITICAL SCALES TO MANAGE FOR SEAGRASS RESILIENCE: PHYSIOLOGY MORPHOLOGY AND LANDSCAPE

Seagrass resilience depends on cross-scale interactions. Management and monitoring of seagrass must integrate across three scales: physiological, morphological and landscape. Interactions among processes occurring at these scales control the ability of seagrass to respond to and recover from disturbance. Recovery is led by small, fast processes occurring at the leaf to plant (physiological) scale, buffered by carbohydrate storage at morphological scales. At the landscape scale, larger and slower processes stabilize the environment. Persistent seagrass loss can arise from three different barriers to recovery: recruitment limitation, recurrence time of disturbance exceeding recovery time, and a change in state such that the environment is no longer suitable for seagrass. Because the ability of seagrass to respond to and recover from disturbance depends on interactions across these three scales, management priorities and monitoring strategies must also act across scales: maintaining ecosystem integrity with periodic monitoring at landscape scales, reducing runoff and disturbances with annual monitoring at morphological scales and facilitating recovery with investigatory monitoring at physiological scales.

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COPEPODITE: AN ONLINE TOOLKIT FOR PLANKTON TIME SERIES DATA ANALYSIS AND VISUALIZATION

The Coastal & Oceanic Plankton Ecology, Production, & Observation Database (COPEPOD) has been providing data handling and programming support to ICES and SCOR plankton time series working groups for over ten years. Through this collaboration, a large collection of specialized time series data analysis, intercomparison, and visualization tools have been developed and featured in a variety of working group publications and monitoring reports. While this tool assortment was originally only available to the working group members, the full toolkit is now available online as part of COPEPOD's Interactive Time-series Explorer (COPEPODITE, http://www.st.nmfs.noaa.gov/copepodite). COPEPODITE's web-based toolkit does not require an expensive software license or a computer-genius to install, operate, and interpret it. With internet access and a generic web browser, any user can upload their own time-series data and quickly produce a variety of time series visualize plots and result sets. Several tool modules are available to help investigate seasonal cycles and interannual trends, and to help highlight correlations between variables within a monitoring site as well as against long-term temperature and climate indices relevant to that site's region. COPEPODITE also features the Plankton Time-series Metabase (http://www.st.nmfs.noaa.gov/copepodite/time-series), which provides information and contact info for over 300 zooplankton and phytoplankton time series, all searchable via a variety of interactive maps and other content-based searching options.

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BOTTOM STRESS IN LONG ISLAND SOUND: OBSERVATIONS AND MODELS

The distribution and variability of bottom stress in estuaries is critical to the understanding of the distribution of sediment and this is important for the characterization of benthic habitats and the choice of sites for the disposal of dredged materials. We report observation of the evolution of near bed shear stress obtained from coherent acoustic Doppler current profilers in Long Island Sound at eight sites that were chosen to represent the range of variations in the estuary. Some sites are dominated by stress due to tidal currents. Others were dominated by intermittent intervals of high wave amplitude. We compare these observations to the predictions of an implementation of FVCOM. The differences between the model and observations are modest are used to bound the errors in prediction of the distribution of bottom stress throughout the estuary.

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OCEAN ACIDIFICATION IN A VARIABLE WORLD: MULTI-SCALE VARIABILITY OF BIOLOGICAL RESPONSES

Many studies on a variety of organisms and ecosystems are revealing a range of potential impacts of ocean acidification on marine communities. Similar efforts in nearshore ocean chemistry are revealing more about the temporal variability of ocean pH. Understanding linkages between biological impacts and chemistry that varies in time and space is critical to predicting the ecosystem impacts of ocean acidification. At the same time, it is vitally important to understand the natural cycles of biological processes that can mask or amplify potential responses to environmental change. For instance, the attachment strength of Mytilid mussels varies seasonally in response to reproductive tradeoffs and changing water temperatures. Experimental studies to assess the impacts of ocean acidification need to gauge how the experimental signals interact or interfere with this natural variability to properly assess ecosystem impacts.

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THE FOULING COMMUNITY ASSEMBLAGE OF OVERWATER STRUCTURES WITHIN THE SOUTHERN CALIFORNIA BIGHT

Overwater structures within coastal estuaries are novel habitats that may facilitate the introduction and spread of non-native fouling organisms by creating substrate that native species are not adept at exploiting. These non-indigenous species (NIS) may threaten already stressed ecosystems, damage aquaculture operations and cause other economic harm. Resource management decisions should include an evaluation of the cumulative impact of actions that facilitate the introduction and spread of NIS. To inform a more comprehensive impact assessment, the overwater structures fouling community within coastal bays and estuaries throughout the Southern California Bight was characterized. Preliminary data

show a greater percent coverage of NIS both underneath and along the sides of structures in high and low flow areas of embayments with a variety of non-native taxonomic groups represented, including ascidians, bryozoans and molluscs. Future work will evaluate prevalence of NIS and quantity of overwater coverage within the embayment. This work highlights the importance of evaluating a full suite of impacts from coastal development projects.

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USING NITROGEN STABLE ISOTOPE TRACERS TO TRACK CLIMATE CHANGE IMPACTS ON COASTAL SALT MARSHES

Climate change impacts on coastal salt marshes are predicted to be complex and multi-faceted. In addition to rising sea level and warmer water temperatures, regional precipitation patterns are also expected to change. At least in the Northeast and Mid-Atlantic U.S., more severe storms and longer droughts are predicted. As the ecological community is gaining a better understanding of how individual factors may impact salt marsh communities, we conducted experimental work to examine at how the combination of sea level rise, precipitation changes, and variations in nutrient loading may stress the salt marshes. These multiple stressor experiments are complicated and data rich but nitrogen stable isotope (δ15N) tracers have proven to be a valuable tool in unraveling some of the complexities—particularly those that are not captured in measured physical parameters (aboveground biomass, plant height, etc.). By adding δ15N enriched in the heavy isotope (15N), we can quantify how efficiently nitrogen is taken up by the system and how it is allocated by plants. Our results from multiple mesocosm experiments and an in-situ salt marsh organ experiment indicate that climate change will decrease the ability of coastal salt marshes to intercept and retain nutrients before they reach sensitive coastal waters.

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FOSTERING POLICY RELEVANT SCIENCE- SEA GRANT IN CALIFORNIA

As part of a larger national network, the two Sea Grant programs in California- California Sea Grant and University of Southern California Sea Grant- operate research and extension programs that meet the needs of decision makers and managers by employing research solicitation, review and extension processes built upon a foundation of constituent and stakeholder input and use. The two programs have collaborated with state agencies to administer research programs of mutual interest that are designed to meet specific state priorities and solicit input from the Resources Agency Sea Grant Advisory Panel (RASGAP), a panel comprised of representatives of state agencies concerned with coastal and ocean management issues, to prioritize research funding decisions. The RASGAP process provides a critical link with academe by identifying current State agency management needs that will benefit from marine research. In the Sea Grant model, extension personnel participate widely in constituent activities that inform the programs about ongoing and emerging coastal and ocean issues and opportunities, and in turn ensure that results of funded research are accessible to decision makers and managers. They play an important role in facilitating the flow of information between the broader marine community and university-based researchers. Input by regional, state and local managers is both informal and formal- through advisory councils comprised of stakeholders and by review of proposals by state and federal agency scientists. Input by users is also often direct- collaborating on projects as co-investigators and mentoring and co-advising graduate students, postdoctoral researchers and policy fellows. Research directors from the Sea Grant programs will provide an overview of the processes utilized as well as examples of successful projects that demonstrate the model for ensuring science relevant to user needs and the utilization of science-based information.

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EFFECT OF EXTERNAL OVERTIDES ON TIDAL BASIN HYDRO-MORPHODYNAMIC FEEDBACKS

The morphology of tidal inlets, estuaries and tidal lagoons is usually characterized by the existence of an ebb-shoal and shallow tidal flats dissected by tidal channels. This complex morphology results from the nonlinear interactions and feedbacks between the external forcing and sedimentary processes. Although the role of internally generated overtides is relatively well understood, the effect of external tidal asymmetry has received little attention. Schutterlaars and de Swart (2000) analyzed the morphodynamic equilibrium solutions for embayments of arbitrary lengths based on the solution of the one-dimensional, cross-section averaged, shallow water equations. The use of cross-section averaged equations limits the applicability of their conclusions to estuaries without the presence of extensive tidal flats. Dissanayake et al. (2009), analyzed the tidal network formation in a two dimensional idealized tidal embayment, indicating the existence of external overtides pronouncedly alter tidal network evolution. The goal of the present study is to gain a better understanding of the specific effect of overtides on the hydro-morphodynamic feedbacks and their dependence on the initial basin configuration. We apply the coupled ROMS-CSTMP model to analyze the hydro-morphodynamic effects of internally and externally generated overtides in three rectangular idealized tidal embayments which are characterized by the same initial inner basin water depth and the same initial tidal prism. While inside the basin the distortion of the tide produces flood dominant condition, offshore of the inlet ebb dominance is observed. The formation of an exterior ebb delta and an inner basin tidal network tend to reduce the tidal asymmetry over time. External overtides significantly modify the evolution of the ebb shoal and the internal tidal network. Exterior ebb dominance increases the volume of the ebb delta, while the food dominance enhances the area of interior tidal flats.

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CO_2 EFFECTS ON THE SEAGRASS *CYMODOCEA NODOSA*: TWO DIFFERENT APPROXIMATIONS

Rising atmospheric CO_2 and its associated increase in seawater CO_2 partial pressure (pCO_2) and decrease in pH are predicted to profoundly affect marine ecosystems. The potential impact of the CO_2 rising on seagrass meadows, highly valuable ecosystems with high productivity and contribution as carbon sinks, is predicted to affect the photosynthetic rates and the productivity of seagrass meadows as well as the functioning of the entire ecosystem. Future CO_2 scenarios can be recreated either in natural areas where predicted high CO_2/ low pH areas are naturally occurring (e.g. thermal vents) or under artificially controlled systems. Natural areas have the advantage that seagrasses are long-term adapted to high CO_2 conditions while artificially controlled systems have the advantage that the physico-chemical characteristics of the water are well defined. The effect of high CO_2 on the net plant productivity (NPP) of the seagrass *Cymodocea nodosa* was evaluated using these two approaches. In a first set of experiments, plants were incubated under natural conditions in Vulcano Island (Italy) using natural seawater and plants from both a reference site (*circa* pH=8.0, 400 ppm CO_2) and a CO_2-venting site (*circa* pH=7.8, 800 ppm CO_2). In another set of experiments, plants were incubated in artificially controlled conditions by bubbling air at 350 and 800 ppm CO_2 in natural seawater. The NPP rates resulted from fast acclimation of *C. nodosa* differed depending on the approach followed. Thermal vent systems have been proposed as natural laboratories for studying the effects of elevated pCO_2 but synergies among the pCO_2, the water composition and the meadow properties need to be considered. On the other hand, artificially controlled systems are simplified systems where plant responses may not provide a sound proxy for natural conditions. The quality of the results and the causes leading different NPP estimates depending on the approach followed are discussed.

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BUILDING A MOSAIC OF PROTECTION FROM ESTUARINE EUTROPHICATION THROUGH THE ADOPTION OF WATERSHED-SCALE NUTRIENT CRITERIA

There has been much scientific discussion about “tipping points”, alternative stable states, or “points of no return” in ecosystem responses to nutrient pollution. These discussions are informative because they provide an understanding of environmental change across spatial and temporal gradients of nutrient pollution. The degree of environmental change that is acceptable as a result of nutrient pollution is a central question posed by researchers, state and federal water quality agencies, and the public. To help answer that question, the Clean Water Act and its implementing regulations identify the achievement of ecological integrity and the protection of designated uses. The expression of these management goals in the context of deriving nutrient criteria for estuaries will be discussed. Focus will be given to the derivation of nutrient criteria across a mosaic of different waterbodies and designated uses that occur within an estuarine watershed drawing on examples from state and federal nutrient criteria development efforts. Other factors that affect (and complicate) criteria derivation and the restoration process when those criteria are exceeded, such as the dynamic nature of nutrient pollution and its effects over time/space, will also be discussed.

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FROM THE CRADLE TO THE CUBICLE: MENTORING MARINE SCIENCE STUDENTS FOR CAREERS IN PUBLIC SERVICE

Many roads lead to a career in public service. Since 1979, the Sea Grant Knauss Marine Policy Fellowship, sponsored and administered by NOAA's National Sea Grant College Program, has introduced graduate students interested in marine policy to careers in public service. Over 900 students have participated in the Knauss Fellowship, which places students within a variety of natural resource management and policy programs across the federal government. The purpose of the fellowship has been to give students experience in the management of natural resources at the national government level. Participating federal agencies have included NOAA, EPA, FEMA, NASA, the State Department, the Department of Interior, Oceanographer of the Navy, US Coast Guard, US Army Corps of Engineers, and the Department of Energy. The fellowship also places students in the legislative branch of Congress where they have worked on Senate and House committees or in offices of an individual member of Congress. The success of the program can be partially measured by the many students who have extended their fellowship experience into careers in public service. That success can be attributed to a number of guiding principles associated with the mentorship in the Knauss fellowship. Some of these principles include a science-centric approach to management and policy-making, encouraging creativity and innovation, empowerment through participation, and fostering a strong ethic in public service. Personal experiences and examples of how these guiding principles have made a difference to students in the Knauss Fellowship will be shared.

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CORAL REEF CONDITION AND BENTHIC SEDIMENTATION THREAT IN FOUR REGIONS OF SOUTH PUERTO RICO

Scleractinian corals, gorgonian octocorals, sponges and fishes were assessed near the cities of LaParguera, Guánica, Guayanilla, and Jobos along the southern coast of Puerto Rico in November – December 2010. Survey sites were targeted near areas with varying benthic sedimentation identified using the Summit to Sea sedimentation model, which uses spatial watershed delineation, soil k-factors (indicating erodibility of the soil type), slope, precipitation, and land cover type to estimate sediment delivery potential at river mouths or other "pour points". Number and condition of stony corals, gorgonians, sponges, fish and macroinvertebrates were measured, and indicators of organism abundance and condition were analyzed to evaluate whether reef indicators showed significant relationships with modeled benthic sediment threat (BT). Across regions, average BT was highest for Guayanilla stations, with averages for Guánica, Jobos and LaParguera stations 59, 23, and 18% of the Guayanilla average. Along with the highest BT, Guayanilla stations exhibited the lowest average number of stony coral taxa, smallest colony size, and lowest colony density. Fish, gorgonian and sponge indicators at Guayanilla stations were intermediate among the regions, and invertebrate abundance including *Diadema* highest. Within regions, indicator correlations with BT were highly variable. Average percent live coral showed a negative correlation with BT for LaParguera stations but a positive correlation with BT in Guayanilla and Jobos. The average density of gorgonians negatively correlated with BT for LaParguera and Jobos, but positively correlated with BT at Guayanilla. Contrasting regional relationships could be influenced by differences in coastal land uses and also by sediment transport dynamics that are not captured in the watershed threat model. The sedimentation threat model may be a better predictor of stress to coral reefs across regional scales compared to within-reef scales.

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HYDRODYNAMIC RESPONSE OF THE PAPALOAPAN ESTUARY TO A POTENTIAL FUTURE SEA-LEVEL RISE

Understanding the hydrodynamics in estuaries with respect to magnitudes of sea-level rise is important to comprehend the changes of distinct physical processes which are coupled among each other. The current state of the lagoons and rivers of the Papaloapan estuary, Ver., is studied in order to identify these processes and have a base line with which compare different sea-level rise and hydrological regimes scenarios, with particular attention in the average salt content, its change in different zones, and the intrusion length into the rivers. For this purpose, hydrography, water level, salinity, bathymetry, and current measurements were carried out, complementary to this, a coastal ocean model is implemented to study the response of the region to a sea level increase. Six oceanographic expeditions in which 49 stations of CTD were carried out and 11 thermistors were placed, it was found that the major tidal components are O1 and K1, with an amplitude of 13.5 and 12.3 cm respectively in the channel, followed by the Q1, N2 and S2 components according to the amplitude. Salt content upstream the rivers show more increase in the dry period than in the wet period of the year. In addition, hydrographic data show that in most of the surveys, Camaronera lagoon had larger salinity than Buen Pais, Alvarado and Tlalixcoyan lagoons.

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THE DIVERSITY OF BACTERIAL COMMUNITIES ACROSS A NORTHERN GULF OF MEXICO ESTUARY SHOW STRONG SEASONAL PATTERNS AND RAPID RECOVERY FROM OIL EXPOSURE

A two-year study in the northern Gulf of Mexico (nGOM) was undertaken to characterize seasonal patterns in the bacterial community across a river dominated estuary. Bacterial communities in surface samples from four sites were followed using 16S rRNA gene sequencing. No significant differences in richness or diversity were detected between the inshore and shelf sites. Shannon diversity was lowest in the winter compared to the rest of the year, but the Chao1 estimate showed no significant seasonal pattern. Shannon diversity positively correlated with temperature, day length and the rate of microzooplankton grazing on bacteria. Significant differences in community composition were detected between inshore and shelf samples, although unassigned Bacteria (23.97% ± 1.93) and Alphaproteobacteria (38.70% ± 3.46) were the most abundant taxa in all samples. Canonical discriminant analysis indicated that season explained 62% of the community variability inshore and 82% of community variability on the shelf. On the shelf, temperature explained only 10% of the community variability, while the combination of temperature and salinity inshore explained 24% of the variability. This suggests that other factors drive the observed patterns. Indirect effects, such as seasonal variability in phytoplankton and DOM composition, and top-down effects, such as grazing and viral lysis, may play a role in shaping the bacterial communities in the nGOM. Sampling covered the period during the Deepwater Horizon oil spill, and the two shelf sites experienced oiling in June 2010, during which no samples were collected. It is possible that the bacterial community was affected by the oil, but that the impact was transient. The high similarity between summer samples, regardless of year sampled, suggests that any perturbation of the community due to the oil resulted in a rapid recovery, indicating a highly resilient bacterial community in surface waters of the nGOM.

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LONG-TERM CHANGES IN FISH COMMUNITY IN RESPONSE TO FLUCTUATING SAV BEDS

Submerged Aquatic Vegetation (SAV) is an important component of the Potomac River ecosystem. There are several benefits of healthy SAV beds, but most importantly to this study, is the use of SAV as nursery and feeding habitat for adult and juvenile fin fish. Using data from the Virginia Institute of Marine Science and the District Department of the Environment, we were able to correlate long-term changes in acres of submerged aquatic vegetation and cover density with the fish community in District of Columbia waters (Potomac and Anacostia Rivers). Using community metrics calculated from a long-term electrofishing dataset, we found that an overall trend existed at twelve sampling sites in the Potomac and Anacostia Rivers for hectares of SAV and species diversity (H), species richness, and relative abundance. There appears to be a one to two year lag in the reaction of the fish community to decreasing trends in SAV, and an almost immediate reaction to increasing trends in SAV area. When examining trends in SAV cover density and sportfish, the most significant changes were found at sites where SAV has disappeared over the course

of the study period. Largemouth bass, yellow perch, and black crappie were the most highly correlated sportfish species when looking at trends in SAV cover density. Total area as well as the cover density of SAV beds both help shape the fish community in the Potomac River. Changes seen in community metrics may be attributable to a lack of feeding or nursery habitat.

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CLIMATE CHANGE AND TIDAL WETLAND FOUNDATION SPECIES: THRESHOLDS, RESILIENCE, AND ALTERNATIVE STABLE STATES IN THE NORTHERN GULF OF MEXICO

In tidal saline wetlands, salt marsh and mangrove foundation plant species play an important functional role: they create habitat and support ecosystems. Climate change is expected to alter the distribution and abundance of foundation species, which would likely affect some ecosystem goods and services. We investigated the potential effects of climate change upon tidal wetland foundation plant species in the northern Gulf of Mexico. We examined the effects of regional climate variability upon foundation species occurrence and abundance and used climate and tidal wetland habitat data to quantify climate-wetland habitat linkages. Our results identify non-linear relationships and regional climate-ecological thresholds which we used to identify coastal reaches with stable (more resilient) and unstable (less resilient) tidal wetland ecosystems. We quantified winter climate thresholds that separate salt marshes from mangrove forests. We also quantified freshwater availability thresholds that separate unvegetated wetlands (i.e., hypersaline tidal flats without foundation species) from vegetated wetlands (i.e., mangrove forests and/or salt marshes with foundation species). We used the identified thresholds and simple distribution and abundance models to evaluate the potential effects of alternative future climate change scenarios. In the northern Gulf of Mexico, the interaction between temperature regimes and freshwater availability is particularly important. In some coastal reaches, relatively small changes in winter severity and/or freshwater availability can trigger relatively dramatic landscape-scale ecological change (i.e., ecosystem transformations between salt marshes, hypersaline tidal flats, and/or mangrove forests). Our analyses highlight the importance of accounting for macroclimatic change in long-term ecological forecasts and planning for coastal wetlands.

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COLLABORATIVE RESOURCE MANAGEMENT INSPIRED BY JOINT FACT-FINDING, STORYTELLING AND BROAD ACCESS TO DATA: OPENNRM AND CALIFORNIA'S ESTUARIES

Large-scale environmental management, such as estuary science in California, requires policy and management action not only at the local level, but at regional and state levels. Estuary ecology, along with social, political and economic considerations, can influence policy design and implementation. The OpenNRM Workspace helps communities to integrate these sciences and facilitate discussion by organizing and simplifying often-complex processes into a format that the public, policy makers and managers can understand, use and amend. The California Estuary Workgroup is working to make this a reality with a toolset that brings together datasets (Environmental Data (EMP, IEP, USGS studies)), Hydrologic Data (CDEC, NWIS,CUASHI), Species Data, Geographic Data, Project Data and Documentation, Sensor Network Data and combines them with useful workflow tools to help practitioners tell their stories. The OpenNRM collaborative workspace is a web-based toolset for organizing, analyzing and managing natural resources. The collaboration suite is composed of a number of interdependent software modules that may be chosen and assembled for a cohesive architecture. OpenNRM focuses not only on consuming and viewing maps and information; it is used for the production of maps, data, decision models and visualization. Bringing information together and allowing for synthesis is critical for successful management in a world where stakeholders are expected to encompass a wide range of competencies. Using Open Source Tools can help address the difficult challenges ahead. More importantly, the open platform allows for innovation from the world of developers who can create specific problem-solving applications and tools based on regional or issue specific needs. OpenNRM is currently implemented as a collaborative scientific and project management community for the Sacramento San Joaquin Bay Delta.

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IMPACTS OF CLAM AQUACULTURE ON NUTRIENT CYCLING IN A COASTAL EMBAYMENT

Eutrophication of coastal and estuarine waters contributes to the degradation of water quality both in the US and globally. Declines in water quality are often accompanied by the loss of living resources including filter feeding bivalves and seagrasses. Aquaculture of bivalves has become more popular in recent years with the depletion of natural stocks in many systems. Filter feeding bivalves have the potential to help remediate the effects of eutrophication through incorporation of nutrients into biomass and by enhancing sedimentary denitrification. To better understand the impacts of bivalve aquaculture on nutrient dynamics, we measured nutrient fluxes and denitrification seasonally under dark and illuminated conditions at an on-bottom culture of *Mercenaria mercenaria* in a coastal embayment (Isle of Wight Bay, Maryland). In general, fluxes of both $NH4^+$and SRP were enhanced at the aquaculture site compared to the adjacent control site while denitrification was similar at both sites. Higher organic loading at the aquaculture site increased sediment metabolic rates but favored $NH4^+$ recycling over denitrification. Low denitrification efficiency in the clam culture was in contrast to recent measurements of mature oyster reefs, suggesting that clam beds may lack the 3D structure and sufficient exposed surface area for nitrification. The impacts of clam culture on nutrient dynamics to the system are likely to be negligible due to the high proportion of nutrient recycling in the water column and the incorporation of both N and P into biomass.

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PRELIMINARY COMPARISON OF RAPID ASSESSMENT AND INTENSIVE MONITORING DATASETS FOR COASTAL WETLAND HEALTH IN THE MID-ATLANTIC REGION

Tidal marshes provide abundant ecological and economic services directly and indirectly, a fact that was highlighted recently by their flood protection value for coastal communities (Hurricanes Irene, Sandy). Despite increasing awareness of their values, coastal wetland losses and degradation continue in the Mid-Atlantic region. Stressors causing these declines include habitat and hydrological alteration, sea level rise, and development. Working with state and federal entities, we worked to design and implement a four-tiered program to examine stressor-response relationships and to track change in coastal wetlands in the region. This Mid-Atlantic Coastal Wetlands Assessment (MACWA) includes an array of nine fixed monitoring stations (Tier 4) that span the tidal gradient and have varying anthropogenic histories. Physical, chemical and biological conditions are monitored annually at these stations, including 3 surface elevation tables per site, fixed RTK-GPS transects, quadrats for studying plant and animal communities, and analyses of sediment and water chemistry. Preliminary example data from the program's first 2 years indicates that marsh elevations are lower in Barnegat Bay than along Delaware Bay, and marshes that have higher suspended solids and nutrient loadings also have lower sediment organic content. Selected metrics from the station monitoring were contrasted with selected rapid assessment metrics (Tier 2) that were examined at 180 sites. Rapid assessments examine buffer, habitat, hydrology, and shoreline condition. Results demonstrate that intensive data from fixed stations can indeed "ground-truth" selected rapid assessment results, thereby facilitating geospatial extrapolation of rapidly assessed data and confirming the value of a multi-tier approach to tracking coastal wetland condition.

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HYDROLOGIC VARIABILITY ASSOCIATED WITH CLIMATIC CHANGE: ITS EFFECT ON PHYTOPLANKTON BIOMASS AND COMPOSITION IN 2 LAGOONAL NORTH CAROLINA ESTUARIES

Nutrient enrichment and variability in freshwater (FW) input play dominant roles in determining the structure and function of estuarine phytoplankton communities. This is especially true for lagoonal estuaries, where water flushing and residence times show large variations in response to changes in FW inputs. In coastal North Carolina, eutrophication and

an increased frequency in extreme climatic (hydrologic) events have impacted phytoplankton dynamics, biogeochemical cycling, and water quality. We used a 17 year (1994-2011) data set from the Neuse River Estuary, and a 4 year (2007-2011) data set from the nearby New River Estuary to examine the effects of acute (storms, floods, droughts) and seasonal hydrologic patterns on phytoplankton community biomass and composition. Specific taxonomic groups optimized growth under varying hydrologic conditions, including seasonal wet/dry periods, storms, and droughts. Changes in phytoplankton community composition and biomass, determined by diagnostic photopigments and microscopic analyses, were modulated by the amounts, duration, and seasonality of FW discharge. In both estuaries, total phytoplankton biomass and the dominant nano/microplankton taxa exhibited a distinctive non-monotonic pattern in response to varying flushing times resulting from event-scale (major storms, hurricanes) and seasonal changes in FW input. Unlike the net negative growth seen at long flushing times for nano/microphytoplankton, picophytoplankton showed positive net growth due to their competitive advantage under nutrient-limited conditions. These relationships can be used to predict relative changes in phytoplankton community composition in response to hydrologic events and changes therein. Freshwater inputs, while not manageable in the short-term, must be incorporated in water quality management strategies for these and other estuarine ecosystems facing increasing frequencies and intensities of tropical cyclones, flooding, and droughts.

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CONTROLLING EUTROPHICATION ALONG THE WATERSHED- TO COASTAL CONTINUUM: MERGING FRESHWATER AND MARINE PARADIGMS IN DESIGNING EFFECTIVE NUTRIENT MANAGEMENT STRATEGIES

Coastal watersheds support nearly 75% of the world's human population and are experiencing unprecedented urban, agricultural and industrial expansion. The freshwater-marine continua draining these watersheds are increasingly impacted by nutrient inputs and resulting eutrophication, including harmful algal blooms, hypoxia, finfish and shellfish kills and loss of higher plant and animal habitat. In addressing nutrient input reductions needed to stem and hopefully reverse eutrophication, phosphorus (P) has received priority in upstream freshwater regions, while controlling nitrogen (N) inputs is often prescribed for estuarine and coastal waters. Intense human activities have caused imbalances in N and P loading, making it difficult to control eutrophication along the continuum by reducing only one nutrient. Furthermore, controlling only one nutrient upstream (e.g., P) been shown to exacerbate N-driven eutrophication downstream. There are an increasing number of examples in these watersheds where duel N and P input constraints is the only effective management option for long-term control of eutrophication. Nutrient reduction formulations should take climatic changes (warming, changes in rainfall and freshwater discharge) into consideration, because these may alter nutrient-eutrophication thresholds. Examples from Europe, North America and Asia will be discussed.

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PARTICLE OVERLOAD! THE EASTERN OYSTER'S ROLE IN BIOGEOCHEMICAL CYCLING UNDER CHRONIC EXPOSURE OF SEDIMENT AND NITRATE

Oysters provide numerous ecosystem services including habitat provision for many species, improvement of water quality, and facilitation of biogeochemical cycling. Suspension feeding results in the removal of particles from the water column and subsequent transference of nutrients to the sediment, thus playing an important role in benthic-pelagic coupling. Populations of the Eastern oyster *Crassostrea virginica* have been declining over the past several decades due to environmental degradation, disease, and overharvesting. While the effects of extreme levels of environmental pollutants have been documented, less is known about the sub-lethal effects of chronic inputs such as nutrients or suspended particles that affect ecosystems throughout the oyster's range. In laboratory experiments, we monitored oyster feeding and condition responses to treatments that received elevated levels of two key pollutants found in the tidal creeks systems southeastern North Carolina, inorganic suspended solids (TSS) and nitrate over a series of 26-day trials. Moderate increases in levels of nitrate and TSS did not cause changes in the gaping behavior or condition index of the eastern oyster over the short-term duration of this study; however, these additions, primarily TSS, did lead to increased total fecal production. Constant organic levels in feces even with greater particle loading reflect changes in feeding, and potentially assimilation, rates of oysters, suggesting the ability to adapt to acute inputs. Although TSS impacted feeding physiology of oysters, nitrate did not affect the fecal production in our study. Once we understand how oysters respond to their environment, we can then implement restoration techniques more effectively to recover oyster populations.

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THE SAN DIEGUITO WETLANDS RESTORATION: A LARGE WETLAND MITIGATION PROJECT IN SOUTHERN CALIFORNIA

The San Dieguito Wetlands Restoration Project (150 acres) is required of Southern California Edison (SCE) by the California Coastal Commission (CCC) as partial mitigation for adverse impacts to the marine environment caused by the operation of the San Onofre Nuclear Generating Station (SONGS). The restoration included excavation and grading to create intertidal salt marsh (92 acres), mudflat, and a subtidal basin (44 acres). An important element of the project is the inclusion of performance standards by which the success of the restored wetland is evaluated. These include long-term physical standards pertaining to topography, water quality, tidal prism, and habitat areas, and biological performance standards pertaining to fish, invertebrates, birds, vegetation, Spartina canopy architecture, reproductive success of marsh plants, food chain support functions, and exotic species. Important elements of post-construction monitoring are that monitoring is conducted independently of SCE and that the success of the restoration project is measured relative to reference wetlands located in the region. While the primary purpose of the monitoring is to evaluate the success of the wetland mitigation project in meeting performance standards, the collected data also track wetland development, identify opportunities for adaptive management, and provide insight into short and long-term processes that affect the ecological function of coastal wetland ecosystems.

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APPLICATION OF RELATIVE SEA-LEVEL RISE SCIENCE TO THE STATE OF LOUISIANA'S PROTECTION AND RESTORATION PROGRAM, FROM 2012 MASTER PLAN ANALYSIS TO INDIVIDUAL PROJECT PLANNING AND DESIGN

Of the environmental drivers influencing coastal zone planning and the success of coastal protection and restoration projects, relative sea-level rise (RSLR) is one of the most important. This is especially the case in southern Louisiana, where variable but potentially very high rates of subsidence contribute to some of the highest recorded rates of RSLR in the United States. In 2012, the State of Louisiana's Coastal Protection and Restoration Authority (CPRA) completed its second Comprehensive Master Plan for a Sustainable Coast, which laid out a 50-year, $50 billion strategy to design and build a set of protection and restoration projects. The Master Plan models accounted for multiple scenarios of eustatic sea-level rise (ESLR), spatially-variable subsidence and marsh accretion/collapse, utilizing the state-of-the-science available when the modeling and planning effort was initiated in 2009. The final analysis of the Master Plan "Less Optimistic Scenario", which assumed 1-meter ESLR by 2100 and to which the Master Plan project attributes were formulated, predicted a loss of 4500 square kilometers of coastal wetlands by 2061 in the absence of a concerted restoration program. CPRA conducted a subsequent peer- and publically-evaluated technical review of sea-level rise science in 2012. Project planning and engineering guidance based on that technical review recommended primary project formulation assuming 1) 1-meter ESLR by 2100, bracketed by scenarios of 0.5- and 1.5-meters ESLR by 2100; 2) spatially-variable subsidence; and 3) continued use of the Master Plan accretion model. This was adopted for the implementation of the CPRA's projects going forward, including several high-profile river diversion projects outlined in the Master Plan. This presentation will trace the history of the State's accounting for relative sea-level rise, including details of the methods used for the Master Plan and the subsequent refinements now being used for project planning.

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STORM-DRIVEN SEDIMENT TRANSPORT AND DEPOSITION IN THE UPPER CHESAPEAKE BAY: FIELD OBSERVATIONS AND MODEL SIMULATIONS

Episodic flood and storm events are important drivers of sediment dynamics in estuarine and marine environments. Sediment dynamics associated with these events have been well-documented by field and modeling studies, though both techniques have inherent limitations. A unique opportunity to integrate field observations and model simulations was provided in late August/early September 2011 with the passage of Hurricane Irene and Tropical

Storm (TS) Lee in the Chesapeake Bay region. Because these two storms occurred within a relatively short period of time, both are potentially represented in the sediment record obtained during rapid-response cruises in September and October 2011. Associated sediment deposits were recognized in cores using classic flood-sediment signatures (fine grain size, uniform ^{7}Be activity, physical stratification in x-radiographs) and were found to be <4 cm, thickest in the upper Bay. Model simulations conducted for TS Lee generally agreed with these estimates. In contrast, Hurricane Irene was not associated with dramatically increased sediment delivery to the Bay but rather with extreme wave activity. Sediment resuspension, and subsequent redeposition, due to this increased wave activity is represented in a sediment core that shows physical stratification but has no detectable ^{7}Be. The differences in the sedimentary response to these events, as well as Superstorm Sandy, will be discussed within the context of storm characteristics that will facilitate anticipation of future storm impacts.

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ENVIRONMENTAL MODELING WITH COASTAL STAKEHOLDERS

A premise emerging in the social science study of environmental modeling is that models are tools of and for decision-making, and thus non-scientific criteria also influence the choice of parameters and other crucial elements of the model design process. This premise supports a position that environmental modeling needs to move beyond attempts to figure out how best to communicate models to policymakers and other stakeholders to more integrated efforts to include institutional and stakeholder factors into the modeling process from the beginning. Participatory modeling has provided valuable experience in the practice of integrating model stakeholders into model conceptualization, design and implementation. Still, there has not been sufficient integration of social science theory and methods to support these participatory efforts. In this paper, we discuss four areas where social science research on modeling can provide valuable theoretical, methodological and practical guidance to advance considerations of model stakeholders. These four areas are: 1) understanding the cultural knowledge frameworks stakeholders use to understand, support, dismiss, or resist the process and results of environmental models; 2) re-interpreting model uncertainty as a reality widely shared by stakeholders and thus an area of opportunity to exchange knowledge, build rapport, and nuanced understanding of environmental modeling; 3) integrating the institutional and management contexts of environmental modeling, rather than treating these political, social and economic factors as exogenous factors; and 4) understanding the non-model cultural, social and economic factors that foster different forms of resistance to environmental modeling. In discussing these four areas, we draw upon on-going research and collaboration with scientists and modelers in the Chesapeake Bay watershed.

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SEA LEVEL RISE AND THE CALIFORNIA COASTAL ACT: PREPARING FOR THE FUTURE

Climate change is a significant challenge for the California coast. In particular, flooding and erosion from accelerated sea level rise could have serious consequences for coastal resources, including loss of wetlands and environmentally sensitive areas, loss of public access areas, and property damage to historic communities, agricultural sites, and scenic highways. The Coastal Act of 1976 mandates the California Coastal Commission (CCC) to "protect, conserve, restore, and enhance" the state's coastal resources for the future. The Act provides the basis for the Commission to adapt the state's coastal management policies to cope with anticipated impacts from sea level rise. The Coastal Commission has developed draft sea level rise policy guidance, and will be releasing the guidance for public review in late summer 2013. This presentation will present an overview of the CCC's sea level rise policy guidance, and the role of the Coastal Act, state coordination efforts, and local government input in developing effective guidance. It will include lessons learned from the CCC's involvement in existing climate adaptation efforts in the coastal zone and provides recommendations for how the Commission can further support local government adaptation efforts, within the context of the Coastal Act. The goal of the Commission's guidance is to help ensure that sea level rise is effectively integrated into coastal management decisions throughout the state, including Local Coastal Programs, or plans that guide the development and protection of coastal resources at the local level.

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CARBON, NITROGEN, AND PHOSPHORUS INCORPORATION BY THE INTERTIDAL SEAGRASS *ZOSTERA JAPONICA* IN THE INTERTIDAL ZONE

The intertidal seagrass Zostera japonica distributed in the intertidal and shallow subtidal zones absorbs nutrients that come from land-based discharge and stormwater runoff before over-enriched nutrients are washed out to sea. In spite of the ecological importance of Z. japonica in the intertidal zones, few studies have conducted on the ecology and physiology of Z. japonica in Korea. In this study, we evaluated the role of Z. japonica as a nutrients sink based on the measurements of productivity and tissue nutrients (carbon, nitrogen and phosphorus) content. This study was conducted on monotypic meadows of Z. japonica in Koje Bay on the southern coast of Korea. Average total, above- and below-ground productivity per shoot was 0.56, 0.34 and 0.21 mg DW shoot-1 day-1, respectively. Annual leaf production was 1.5 times higher compared to annual below-ground production. Estimated annual whole plant carbon, nitrogen and phosphorus incorporations based on shoot production and tissue nutrients content were 312.8 g C m-2 y-1, 25.7 g N m-2 y-1 and 1.6 g P m-2 y-1, respectively. These values were equivalent to 7.8 × 103 kg C y-1, 6.4 and 1.8 × 102 kg N y-1 and 40 kg P y-1 for all Z. japonica beds in Koje Bay. This indicates that Z. japonica meadows can incorporate a considerable amount of carbon, nitrogen and phosphorus in the intertidal zone.

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INSIGHTS INTO PHYTOPLANKTON AND NUTRIENT INTERACTIONS IN CENTRAL SAN FRANCISCO BAY, CA THROUGH A DECADE OF OBSERVATION

Although difficult to sustain, regular long-term monitoring of estuaries has proven invaluable in providing insight into ecosystem forcing in the face of anthropogenic perturbation. Several regions of the San Francisco Estuary (SFE) are among the most studied systems in the world. The freshwater SFE Delta is intensively surveyed as it is a hub of California's water infrastructure while South San Francisco Bay, with its lagoon-like circulation, is routinely monitored for eutrophication potential. In contrast, Central San Francisco Bay, that links the SFE to the Pacific Ocean, has received relatively less research attention. A monitoring station at the Romberg Tiburon Center, SFSU, was established in Central Bay in 2001, allowing for detailed long-term evaluation of processes that govern nutrient and phytoplankton interactions. Continuous meteorological and salinity and temperature records, along with high frequency nutrients, extracted chlorophyll-a, and algal size-spectra with flow cytometry provide the backbone of Central Bay monitoring. Additional special studies, including those for primary production and phytoplankton species enumeration have been included for different periods in the data record. The long-term record reveals regular seasonal patterns of nutrient concentrations and phytoplankton that appear strongly governed by freshwater flow out of the SFE Delta, particularly during anomalously wet and dry years The magnitude of phytoplankton blooms within the SFE may intercept anthropogenic nutrient loads, modulating the delivery of nutrients to the coastal Pacific Ocean. During summer and fall the influence of the Pacific Ocean on SFE nutrients and phytoplankton may be more pronounced. Insights gained from this analysis should help elucidate the links between climate and increased water demand on biogeochemical functioning of river-dominated estuarine systems.

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ROLE OF FROST TOLERANCE VERSUS CLIMATE CHANGE IN MANGROVE RANGE EXPANSION

Mangroves are tropical and subtropical tree species that have recently begun moving into temperate zones, suggestive of a warming climate. Alternatively, poleward expansions could also result from selection for cold-tolerant individuals at the edge of the range. To distinguish between these two mechanisms, we examined variation in cold-tolerance among three common mangrove species (black mangrove Avicennia germinans; white mangrove Laguncularia racemosa; and red mangrove Rhizophora mangle). We sampled individuals along Florida's eastern coastline, ranging from southern populations where frost events are exceedingly rare to northern populations where frosts are common. In the laboratory, adult branches and propagules were subjected to experimental frosts, after which we recorded loss

of leaf photosynthetic function, and monitored the growth and survival of the propagules. We also measured a suite of ecophysiological leaf traits to mechanistically explain these results. We found strong differences in frost tolerance among species across both adults and offspring, with black mangroves usually showing the greatest tolerance and white mangroves the least. Species also differed in their cold acclimation. Differences were correlated with species' latitudinal distributions, suggesting that differential range limits across species are a function of frost tolerance. Despite finding latitudinal differences in multiple leaf traits, there was no latitudinal gradient in adult frost tolerance within species. Leaf traits of offspring and adults were generally non-correlated, suggesting low heritability of frost tolerance. Thus, we found no evidence that latitudinal shifts in mangrove distributions are being driven by selection for cold-tolerant individuals at the edge of the ranges. Instead, our results suggest that mangrove expansion into temperate latitudes is likely due to a warming climate.

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WITH WILDLIFE IN MIND: CITIZEN SCIENCE AND A THREAT-BASED LOOK AT MARINE DEBRIS

The Coastal Observation and Seabird Survey Team (COASST) is a citizen science program that trains participants to survey beaches monthly and collect beached bird data in a standardized, rigorous manner. This highly accurate and independently verifiable data set creates the baseline against which a variety of factors, including anthropogenic factors, can be assessed. Since its inception in 1999, COASST has grown to over 800 people surveying 400 beaches across four states. Responding to the interest of current beached bird surveyors, in 2012 COASST launched a special project to look at the types of debris that catch the eyes of beach observers and their characteristics (i.e. shape, color, size) as they relate to wildlife harm for specific marine species (e.g. pinnipeds, otters, albatross, sea turtles). At over 5,000 images, this is the first step in a) mapping harm to wildlife across the West Coast b) monitoring changes in debris deposition and persistence, and c) involving and connecting the public to the science of marine debris and its connections to marine policy and conservation.

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IMPROVING WATERSHED HEALTH THROUGH LARGE-SCALE WETLAND RESTORATION

Wetlands play many important functions for both wildlife and humans. However, these functions are lost when wetlands are developed or altered. Tomales Bay, located 30 miles north of San Francisco Bay, lost 50% of its wetlands in the 1940s when a large marsh was leveed for a dairy ranch. In 2008, the National Park Service completed a 613-acre restoration project of the former ranch. The Park Service believed that restoration could not only improve the quality of the remaining degraded wetlands within the ranch, but improve overall watershed health by increasing habitat for wildlife, as well as improve water quality. While this Ramsar Wetland of International Importance is considered pristine, its waters have been impacted by leaking septic tanks, agriculture, and mercury and are considered impaired under Section 303(d) of the Clean Water Act. To determine success of restoration in improving wetland functionality, the Park Service developed a pre- and post-restoration long-term monitoring program that incorporated both the restoration area and reference wetlands. Monitoring in the five years since levees were breached has documented some dramatic changes that have occurred more rapidly than anticipated. Water quality has improved considerably. Tidal influence has transformed the former pastures into a complex mosaic of salt marsh, brackish marsh, and freshwater marsh habitats that support a number of uncommon and even rare plant species. Invertebrate communities have shifted in composition and increased dramatically in numbers, increasing the attractiveness of the restored wetlands to shorebirds and other species. Waterbird numbers have climbed dramatically every winter since restoration, particularly waterfowl abundance. As the project moves beyond year 5, project managers will be focusing monitoring efforts on the resilience of this restored wetland to climate change impacts such as sea level rise and changes in salinity structure.

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SYSTEM-WIDE ASSESSMENT AND MONITORING PROGRAM (SWAMP)

Louisiana and its partners have allocated considerable resources and have made long-term commitments to restoration and management of wetland and aquatic resources in the coastal zone. Efficiencies of scale and leveraging opportunities from multiple programs have been realized with the Coastwide Reference Monitoring System-Wetlands (CRMS-Wetlands) and Barrier Island Comprehensive Monitoring (BICM) programs. Louisiana's 2012 Coastal Master Plan heavily utilized data from CRMS-Wetlands sites for its decision support tools; and events such as the hurricanes Gustav and Ike in 2008, and Isaac in 2012, and the 2010 MC252 Oil Spill have utilized data from CRMS-Wetlands and BICM to document environmental baselines conditions and impacts from these events. For more on CRMS-Wetlands, see oral "Assessing coastal Louisiana's resiliency to droughts, floods, and hurricanes utilizing data from the Coastwide Reference Monitoring System" by Sharp and Weifenbach, and poster "Analytical data tools employed by Louisiana's Coastwide Reference Monitoring System" by McGinnis, Sharp, Wood, and Weifenbach elsewhere in the program. As Louisiana implements its 2012 Coastal Master Plan, the state is developing a System-wide Assessment and Monitoring Program (SWAMP) that will incorporate additional integral variables to support adaptive management and planning model refinement. These include data such as comprehensive LiDAR datasets to monitor elevation changes; comprehensive vegetation surveys to document changes in habitat; coast-wide land:water analyses from satellite imagery to monitor land loss rates; and baseline geologic conditions that relate to processes such as subsidence and relative sea level rise. This effort includes inventorying and leveraging existing state, federal, and local efforts and will focus on the important parameters needed to support the restoration and protection program and to understand the overall health and evolution of the coastal system.

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AMMONIUM CYCLING IN THE ROCKY INTERTIDAL: REMINERALIZATION, REMOVAL, AND RETENTION

Rocky intertidal productivity is traditionally thought to be sustained almost solely by upwelled nitrate with remineralized forms of minor importance. Using tidepools as natural experimental mesocosms, we conducted ^{15}N tracer experiments to test whether ammonium remineralized within the rocky intertidal is also a significant source of fixed N to localized ecosystem production. Comparison of tidepools with and without the dominant bivalve, *Mytilus californianus*, allowed consideration of its role in NH_4^+ cycling. Closed water incubation bottles were used to investigate the contribution of suspended microbes to NH_4^+ cycling. Tidepools with mussels had both greater NH_4^+ remineralization (two times) and NH_4^+ removal as compared to those without, with daytime rates greater than nighttime rates. Incorporation of $^{15}NH_4^+$ tracer by particulate organic matter and macroalgae, and the persistence of this signal in tidepools for several days following the experiment, showed retention of autochthonous NH_4^+ in the system. Remineralization rates were tightly correlated to removal rates when compared over all treatments and experiments, but NH_4^+ remineralization was significantly greater than removal, suggesting a surplus available to nearshore primary producers. This study thus suggests that rocky shore animal populations may generally serve a critical role in ecosystem nutrient cycling and highlights the importance of conserving this function for ecosystem management.

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USING GIS IN WETLAND RESTORATION AND MONITORING: TIME SERIES OF BRACKISH MARSH EXPANSION IN THE SAN DIEGUITO WETLANDS, CA

The San Dieguito Wetlands Restoration Project is located in Del Mar, California and is one of the largest in California. The restoration serves as "out-of-kind" mitigation required of Southern California Edison for in-plant losses to fish caused by the operation of the San Onofre Nuclear Generation Station (SONGS). Construction was completed following final inlet dredging in September 2011. Constructed habitats include a subtidal basin, tidal mudflats, and low-high salt marsh to be vegetated with salt marsh plants native to Southern California. However, estuaries such as the San Dieguito Wetlands can receive freshwater input from surface and groundwater flows, hence salinity values may vary throughout the wetland influencing vegetation development. The aim of this study is to quantify the expansion of unplanned brackish marsh vegetation within the restoration site using GIS and explore its relationship with soil salinity gradients during and after wetland construction (2009 – 2012). Noticeably, brackish marsh vegetation (including Typha sp., Scirpus sp.) has expanded in extent from 2009 (0.01 acres) through 2012 (2.31 acres). Measurements of soil salinity, which ranged from 3 psu to 52 psu with an average of 15.47 psu (2011) and 17.83 psu (2012), confirmed the association of this vegetation with fresh groundwater intrusion. GIS mapping and soil salinity measurements will enable a prediction of the future limit of the unplanned development of vegetation more typically associated with fresh or brackish marsh than tidal salt marsh, and may thus inform restoration planning in other systems.

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MULTI-SCALE CONTROLS OF SUBMERGED AQUATIC VEGETATION IN CHESAPEAKE BAY

Submerged aquatic vegetation (SAV) provides many important ecosystem functions, but SAV is in worldwide decline. We applied statistical models to annual Chesapeake Bay-wide maps of SAV coverage (1984 – 2009) and identified factors that affect spatial and temporal patterns of SAV coverage. Among 99 subestuaries of the Bay, agricultural or developed land in the local watershed and the amount of riprap were significant negative predictors of average annual SAV coverage. Adjacent to individual shoreline segments, shoreline armoring (bulkhead or riprap) reduced average annual SAV compared to natural shoreline, but the armoring effect was significantly stronger in subestuaries with higher salinity or with less agricultural or developed land. Interannual variation in SAV coverage was significantly correlated with interannual variation in riverine nitrogen loads and estuarine chlorophyll a levels in the month of initial SAV shoot growth, but the important month differed among salinity zones. Salinity zone is important in all the analyses, probably because the salinity zones have different SAV communities, and the community responses reflect differences in species-specific responses to stressors. Understanding SAV dynamics requires integrating factors at multiple spatial scales (salinity zones, subestuaries, and shorelines) with temporal variation in SAV drivers controlled by weather patterns.

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RARE PLANT RECOVERY: EFFECTS OF INVASIVE VEGETATION REMOVAL ON PRE-DISPERSAL SEED PREDATION OF A COASTAL DUNE LUPINE

Background and Methods *Lupinus tidestromii* is an endangered coastal dune perennial that is threatened by habitat loss and consumption by native deer mice, *Peromyscus maniculatus*, whose density is inflated in the presence of the invasive beach grass *Ammophila arenaria*. In 2011, the National Park Service at Point Reyes National Seashore conducted a large-scale restoration project removing 80 acres of A. arenaria at Abbotts Lagoon, in an area surrounding the largest population of *L. tidestromii*. We hypothesized that beachgrass removal would reduce pre-dispersal predation on *L. tidestromii*. To test this hypothesis, we measured pre-dispersal predation before and after restoration. Pre-restoration observations were made in June and July of 2008, 2009, and 2010. Post-restoration observations were made in June and July of 2011 and 2012. Population-level predation was measured by observing the proportion of fruiting racemes that were removed per plant and averaging over all plants. Results and Conclusions We found that pre-dispersal predation on *L. tidestromii* was dramatically reduced in post-restoration years, compared to pre-restoration years. Additionally, we observed large areas of recently restored habitat colonized by *L. tidestromii*, indicating that removing beachgrass opens up new habitat suitable for this species. Population models are needed to evaluate how the observed reduction in predation translate into overall reproductive success and population growth rates.

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TRACING DISSOLVED OXYGEN STRESS IN OYSTERS

Low oxygen events are increasing in location and intensity worldwide, creating stress on the organisms that inhabit affected waters. Mobile Bay, AL is known to have seasonal low oxygen events, which can affect the local oyster stocks. To understand the effect of low oxygen stress on oysters, hatchery reared oysters were placed in cages and deployed along with YSI data sondes at two reefs in Mobile Bay, AL that differed in oxygen concentration. To detect and measure sublethal stress due to low oxygen concentrations, we used two types of tracers. We analyzed stable isotope ratios (C & N) and protein biomarkers, including heat shock protein 70 (HSP70) and p38 MAP Kinase in oyster tissues from juvenile and adult oysters. We observed up-regulation of the inducible form of HSP70 (HSP69) in oyster tissues in response to lower DO levels. By combining multiple tracers we hope to define responses to different stressors in oysters. Because oysters are relatively tolerant of low oxygen events, these data can be used to quantify the sublethal stress response that may not be detectable by traditional ecological measurements such as growth and survival. The ability to understand and measure stress in oysters is important for advancing our knowledge of oyster physiology, quantifying anthropogenic and naturally occurring stressors in coastal ecosystems, and informing conservation and restoration efforts.

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TROPICAL CYCLONE STIRRING ON THE INNER CONTINENTAL SHELF OFF NORTH-WEST AUSTRALIA OBSERVED THROUGH OCEAN GLIDERS

Acquisition of surface and sub-surface oceanographic data under extreme weather conditions present many challenges but the use of ocean gliders provide a platform from which water column impacts may be documented. Tropical Cyclone Rusty, a severe category 4 cyclone, made landfall on Western Australia's Pilbara coast on 27 February 2013 and its impact on the inner continental shelf (depth ~ 40m) water column was recorded by two Slocum gliders. The path of TC Rusty bisected the paths of the two gliders. One of the gliders were located in a region where the mean onshore winds were over 90 km/hr which resulted in a rapid increase in the depth mean currents to > 0.8 m/s, a doubling of the background tidal currents. The water column was well mixed in density throughout the period of observation. High sediment resuspension was observed during and after the passage of the cyclone extending throughout the water column. The measured concentrations (backscatter at 700 nm) exceeded the range of the WETlabs eco-puck sensor for a period of 6 days and returned to pre-cyclone conditions after 8 days. The re-suspension event had a strong influence on the light climate by reducing the depth of light penetration from > 40m before the cyclone to < 10 m during the cyclone. The glider data also indicated that TC Rusty stirring resulted in an increase in the chlorophyll concentrations which formed a massive offshore plume which extended over a region in excess of 600 km2.

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EFFECT OF SEDIMENT ORGANIC MATTER AND MINERAL CONTENT ON THE RELEASE OF SILICATE AND ORTHOPHOSPHATE ALONG A SALINITY GRADIENT

During a long-term study (1987-2013), we found dissolved silicate and orthophosphate concentrations had non-conservative behavior in the Guadalupe and Nueces Estuaries. It is hypothesized that sediment composition and pore water chemistry might cause the non-conservative behavior. A lab experiment was performed to measure nutrient release from sediments with and without organic content from the Guadalupe and Nueces Estuaries in five different salinity solutions. The sample mixtures were shaken between intervals in the 48 hours experiment to simulate wind and river forcing. The release of silicate from sediments increased with time from 2 mins to 48 hours in the zero salinity solutions; however the release was comparatively less in higher salinities. The release of dissolved silicate in the treatment without organic matter was higher than with organic matter. The orthophosphate concentration was depleted from most of the solution mixtures containing both estuaries' sediments with organic matter. In the treatment without organic matter, the release of orthophosphate from the sediments to the solution was as high as 52μmol/L.

The sediment minerals quartz and calcite were abundant in the estuaries. The retention and release of orthophosphate from the sediments may have been caused by the bonding with organic matter and calcite in the sediments. Hence the findings indicate organic matter and calcite may be the significant contributor in the low dissolved orthophosphate concentration in the estuaries. The release of silicate from the silicate minerals and organic matter due to the shaking of samples indicate that the combined forcing of river and wind may have been maintaining the estuaries silicate concentrations.

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ANALYSIS OF SHELLS AND SWIMMING BEHAVIOR OF OLYMPIA OYSTER LARVAE EXPOSED TO OCEAN ACIDIFICATION

Drastic declines in native Olympia oyster populations along the west coast of the United States have led to recent intensive restoration efforts. In addition to the inherent challenges of restoration, regional and global ocean acidification poses a threat to the reestablishment of native shellfish. The larval shell is a significant contributor to the larval swimming behavior of Olympia oysters and changes in the larval shell caused by acidified water may cause changes in swimming performance. Cultures of 2-day old larvae were cultured under high (1000ppm), moderate (750ppm), and control (350ppm) concentrations of CO2. After four days of exposure, larval swimming patterns were video recorded for later analysis of swimming behaviors. Larval samples were also collected from each treatment every two days to measure shell growth. There was a significant effect of CO2 concentration on length and number of swimmers ($p < 0.05$), with significantly fewer swimmers in the high than in the moderate CO2 treatment. We could not detect a significant effect of treatment on swimming directional changes ($p=0.47$). Preliminary results suggest that exposure to ocean acidification during the larval life of Olympia oysters may affect shell size and swimming behavior. Determining Olympia oyster larvae swimming behavior in response to acidification will contribute to determining where these larvae move the water column and how restoration efforts should be focused.

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WEATHER, CLIMATE, AND DISTRIBUTIONS OF NATIVE AND NON-NATIVE SPECIES IN NEW ENGLAND

Rapid assessment surveys of native and non-native species were conducted at 101 sites (primarily floating pontoons) during late July/early August 2000, 2003, 2005, 2007, 2010 from Eastport Maine to Staten Island, New York. At these sites, taxonomic experts identified approximately 610 macro-algae and macro-invertebrates of which 34 are designated as non-native species and 37 as cryptogenic species. Many species are distributed over the two biographic cold temperate regions; a warmer Virginian Region and colder Acadian Region. From Maine to New York City species found at more than 50 of the sites were represented: by four native species three of which were the green algae (Ulva spp.) and an anemone (Metridium senile); by three cryptogenic species of hydroids (Obelia spp.); and by four non-native species, two of which were ascidians (Botrylloides violaceus and Botryllus schlosseri), a red alga (Neosiphonia harveyi), and a sponge (Halichondria bowerbankia). Several warm water species found primarily in the southern range appeared to move northward and one alga (Colpomenia peregrina) has moved southward. Diversity at individual sites that were sampled each year varied from year to year. There were fewer non-native species in the northern-most area and greatest diversity of species in Massachusetts, New Hampshire and southern Maine. The role of antecedent weather conditions in distributions is discussed in relation changes over time.

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CLIMATIC VARIABILITY AND THE DIVERSITY OF BRACHYURANS (TRUE CRABS) IN THE ST LUCIA ESTUARY, SOUTH AFRICA

The St. Lucia Estuary is part of the iSimangaliso Wetland Park and a UNESCO World Heritage Site. Despite being strictly monitored and managed, it is characterised by instability and experiences ongoing degradation, both of which have a significant impact on the biodiversity of the estuary and surrounding area. Brachyurans play an integral role in the functioning and maintenance of this ecosystem. Since the surveys undertaken in the early/mid 1900s, no study has focussed on this taxon and species identification has been confounded by the presence of cryptic and pseudocryptic species. This study provides the first comprehensive census of the brachyuran species inhabiting the St. Lucia estuarine lake, highlighting the changes in diversity that have occurred in this region between 1948 and 2012 in response to shifts in climatic conditions, physico-chemical characteristics and management regimes. A total of thirty species was recorded for the area during this period, four of which have not been reported in the previous literature. Under the current conditions of mouth closure persisting since 2002, only sixteen species remain within the system. In particular, all the fiddler crab species (Uca spp.) have been lost with yet unknown consequences for the mangrove ecosystem. The extent to which regional endemic species, such as Paratylodiplax blephariskios, have been affected by ecosystem shifts is also discussed in terms of management of the system, in particular, the estuary mouth. The distribution and abundance of three key species i.e. P. blephariskios, Neosarmatium africanum and Hymenosoma cf. orbiculare are also outlined and possible reasons for observed changes are discussed also in relation to climate change and past management strategies. Possible future scenarios regarding the state of the estuary mouth and the stability of physico-chemical variables are considered and the importance of adaptive, ecosystem-based management is highlighted.

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SPATIAL PATTERNS IN OPTICAL PROPERTIES AND DIFFUSE ATTENUATION COEFFICIENTS IN DELMARVA COASTAL BAYS

Submerged aquatic vegetation (SAV) serves important ecosystem functions such as habitat and food for marine organisms, the stabilization of bottom and shoreline sediments to limit erosion, production of oxygen, and also serve as indicators for coastal ecosystem health. SAV abundance within the coastal bays of Maryland and Virginia increased steadily during the decade of the 1990's, but has fluctuated thereafter. A primary factor limiting SAV abundance is the availability of light reaching the plants. The diffuse attenuation coefficient (Kd) determines the amount of light penetrating the water column. Being able to estimate Kd based on measurements of optical properties within the water column can be useful in determining where and how restoration efforts should proceed. We collected light absorption and scattering coefficients as along with standard water quality parameters, temperature, salinity, chlorophyll and turbidity while underway. With these data we were able to interpolate the conditions within the expanse of the sampling area. Combining the interpolated data with measured data at test sites within the sampling area we were able to estimate the attenuation coefficient and its determinants for the entire sampling region within Chincoteague Bay.

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USE OF HISTORIC DATA TO UNDERSTAND BENTHIC COMMUNITY CHANGES IN NARRAGANSETT BAY

Narragansett Bay, a small northeastern U.S. estuary, has been adversely impacted by eutrophication. Nitrogen loads in the bay have risen as human development has increased, and the bay shows a distinct eutrophication gradient from the head of the bay to the mouth. Sewage treatments plants contribute approximately 50% of the nitrogen to the bay and most loading occurs at the head of the bay near urban centers. In 2003, a large fish kill spurred the legislature to require sewage treatment plants to reduce their nitrogen loads to the bay by 50% during the growing season. In order to understand the ecological implications, the U.S. EPA's Atlantic Ecology Division has been accumulating historical ecological data on the bay. Contemporary work has shown that the eutrophication gradient is reflected in the benthic invertebrate community. Although quantitative benthic invertebrate data have been collected in the bay since the 1950s, surveys have been done intermittently for various projects using different gear. For this study, we examined alternate ways of harmonizing and sub-setting data collected between the 1950s and mid 1980s to minimize these differences so that temporal trends could be observed. This should be helpful for not only this study but also have application to other estuaries where disparate historical data are available.

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THE UNITED STATES OF AMERICA AND MEXICO PERFORM A HISTORIC DEMONSTRATION OF INTERNATIONAL COOPERATION IN ORDER TO CONSERVE WATER AND PROTECT THE ENVIRONMENT ALONG THE COLORADO RIVER

On November 20, 2012, Minute 319 was signed where collaboration over conflict succeeded in setting the stage for decades of cooperative water management where Mexico and the United States will share during times of surplus and shortage. While the current agreement is for five years, the principles that were binationally agreed to will aid both of our countries if climate change continues to impact the region. The objectives of the new agreement allows: a. Fair distribution of water under surplus conditions b. Fair handling of water under shortage conditions c. Share water storage infrastructure and increase access to the resource d. Address water quality during different climatic conditions e. Provide scheduled water for the environment f. Develop a long term International project execution strategies The US and Mexico have agreed to pursue cooperative measures in several areas. These include: distribution of waters during high elevation reservoir conditions, distribution of

waters during low elevation reservoir conditions, the creation of Intentionally Created Mexican Allocation, measures to address salinity impacts, water for the environment programs and the analysis, study and possible implementation of international projects that include desalinization and water conservation. The US and Mexico established a binational Core Groups including Water Conservation, New Water Sources, System Operations, and Environmental. The two countries noted that they were both eager to explore opportunities for cooperative projects that : minimize the impacts of potential Colorado River shortage conditions; generate additional columns of water using new water sources by investing in infrastructure such as desalinization facilities; conserve water through investments in a variety of current and potential uses, including agriculture, among others; and envision the possibility of permitting Mexico to use United States infrastructure.

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ECOLOGICAL IMPLICATIONS OF BLACK MANGROVE EXPANSION IN THE GULF OF MEXICO: INSIGHTS FROM A LARGE-SCALE MANGROVE REMOVAL EXPERIMENT

Black mangroves (Avicennia germinans) are expanding into areas historically occupied by salt marsh plants on the Texas coast. Over the coming decades, mangrove distributions are expected to continue expanding due to rising global temperatures and milder winters. Will this matter? To examine the ecological consequences of these vegetation changes, we set up ten large experimental plots on Harbor Island in Port Aransas, TX, in which we manipulated the density of mangroves in the summer of 2012. Removal of mangroves strongly affected microclimate: wind speed was higher and air temperature lower in plots with reduced mangrove cover. Removal of mangroves also led to expansion of marsh plants, primarily Batis maritima and Sarcocornia sp. We hypothesize that, within the next 2 years, removal of mangroves will also increase soil porewater salinity, affect densities of marine macroinvertebrates (snails and crabs) and terrestrial arthropods (insects and spiders), and affect habitat use by marine nekton and birds.

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ASSESSMENT OF THE ACTUAL LEVELS OF TRACE ELEMENTS AND THEIR SOURCES IN MARINE SEDIMENTS OF THE LA PAZ LAGOON, BAJA CALIFORNIA SUR, MEXICO

The study of the biogeochemical cycles of the elements is important because they regulate the functioning of marine coastal ecosystems. To determine the factors that control the distribution of potentially toxic elements (PTE) in surface sediments of the La Paz Lagoon and their possible sources, 91 sediment samples were collected by free diving. After a total digestion of oven-dried (60 ^{o}C, 24 h) sediments with a mixture of concentrated strong acids (HF+HCNO3+HClO4) the concentrations for over 50 elements were measured with inductively coupled plasma mass spectrometry. The enrichment factors and the Müller's geoacumulation index of the analyzed elements were calculated using obtained data to distinguish naturally or anthropogenically enriched PTEs. A principal component analysis was also used to determine the possible associations between elements. The results obtained allow us to establish that there are natural inputs of elements such as Se, Ag, As, Cd and Sb into the sediments, which reflect mainly the lithology of the geological formations surrounding the lagoon. Greatest enrichments of As and Cd were found in the area adjacent to the Mogote peninsula which may reflect litoral transport of phosphatic materials rich in some trace elements, supplied to the sea by arroyos that cut through the Lomas de la Virgen geologic formation. The Pb probably has anthropogenic origin, because its higher concentrations up to 36.8 mg kg^{-1} were recorded near the La Paz city. To reconstruct the history of contamination by PTE's of the lagoon a 46-cm long sediment core was collected and dated in the deep basin aiming to establish also the sedimentation rate in this embayment and then to measure the concentration of trace elements in this core.

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USING ENVIRONMENTAL HISTORIES TO ASSESS THE WETLAND RESTORATION POTENTIAL OF AGRICULTURE IMPOUNDMENTS

Agriculture impoundments are potential wetland restoration sites. The likelihood of successful restoration is based on many different factors including soil chemistry, hydrology, and geomorphology of an area that may, be unique to the location being restored. We studied the Delta Farms area located south of Lake Salvador, LA, which is bordered on the west by the Intracoastal Waterway. The central region was farmed in 1915 and abandoned in the 1960s when levee failed; it is currently open water habitat. An unfarmed natural marsh borders this area to the east. To the north of the open water region is a former agriculture impoundment that was also farmed by 1915, but abandoned after a levee failure before 1930, and re-vegetated by1933. The three different areas in close proximity to one another create a unique situation to compare the restoration timing, vegetative sequence, and soil development. Aerial photographs were used to document the sequence of vegetative cover since the 1930s. Sediment from the three areas were compared, and the restoration phase of the Northern region was reconstructed using dated sediment cores and various environmental forensic analyses. The subsidence deficit of several feet in the northern area was overcome within 2 decades after levee failure, whereas the 5 feet of subsidence in the current open water has not after 5 decades. Comparisons will be made with other impoundment restorations in the US and Europe.

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ENVIRONMENTORS: MENTORING UNDERREPRESENTED HIGH SCHOOL STUDENTS IN STEM RESEARCH AND ENVIRONMENTAL AWARENESS

EnvironMentors is a nationally coordinated mentoring program that pairs the graduate student and university faculty mentors with high school students considered at-risk and underrepresented in the STEM (Science, Technology, Engineering, and Mathematics) fields. There are currently 13 university chapters in the United States participating in the EnvironMentors Program. Each university chapter is given core goals to incorporate into their program and are encouraged to add goals and a structure that best meet the needs of the mentors and mentees in the program. The LSU chapter recruits mentors from STEM related departments throughout the campus. One or preferably two mentors are paired with students based on scientific interests and compatibility. Our program has shown positive effects in both the mentors' and mentees' personal and academic development. The concentrated time and effort devoted by mentors seems to play a significant role in the students' intellectual confidence and sense of self-worth, which is reflected in improved class performance and participation. Mentors reported feeling a connection with surrounding communities, gaining valuable teaching and interpersonal communication skills, and developing unique problem solving skills. They also face the challenge of gaining trust and engaging their students while working in a limited time frame and budget. Overall, both mentors and students felt they had a positive experience and either repeated or continued to support the program. Future goals include fostering a lasting relationship among students and mentors that extends beyond the scope of the program, and enhancing mentor pairing techniques to improve compatibility.

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CHANGE ANALYSIS OF SEAGRASSES ON MISSISSIPPI BARRIER ISLANDS FROM 1940 TO 2008

Maps of seagrasses on five Mississippi barrier islands (Cat, West Ship, East Ship, Horn, and Petit Bois Islands) from 1940 to 2008 were resampled to a common pixel size of 2 m for change analyses. There were three temporal levels (across all year in 1940-2008, across decades, and across years in the 2000s) and two spatial levels (among islands, and among segments of the same island) examined. Landscape- and patch-leveled metrics were calculated using FRAGSTATS ver. 4.1 (McGarigal et al. 2012) and analyses were performed in R. Firstly, total seagrass area was correlated with the island area; Horn and West Ship Island supported the highest and the lowest cover, respectively. In terms of largest patch index, Petit Bois and West Ship Islands had a substantial lower values compared to the other three islands. Secondly, in the 2000s, on the Mississippi barrier islands except Petit Bois, seagrass patch area, perimeter, radius of gyration, perimeter to area ratio, and Euclidean nearest neighboring distance differed significantly across years but not among islands. The highest values of seagrass patch area were observed on Horn, East Ship, and Cat Island in 2006, while they are in 2003 for West Ship Island and in 1940 for Petit Bois Island. In 2003-2008, seagrasses on Horn, East Ship, and Petit Bois Islands shared a similar trend in mean patch area which increased from 2003 to 2006, decreased sharply in 2007, and then continued decreasing in 2008. Horn and Petit Bois Islands experienced the same trend for mean patch perimeter of seagrass from 2003 to 2008. Thirdly, the differences of seagrass metrics among island segments can be partly explained by the westward movement of the Mississippi islands.

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HOW MUCH OF LOCAL SCALE VARIATION IN PHYTOPLANKTON BIOMASS CAN BE EXPLAINED BY PROGRESSIVELY LARGER SCALE VARIATION?

Long-term observations in coastal waters of the SE North Sea revealed two regime shifts in species composition, i.e. between 1977-1978 and 1987-1988. Both shifts were explained as being the result of changes in riverine inputs. The second shift occurred, however, simultaneously with shifts in phytoplankton biomass in the adjacent NW European Shelf, the eastern central North Atlantic, the west Atlantic and the Pacific Ocean. Such simultaneous shifts at large scales with different impacts on local scales suggest the strong influence of large climate impacts on developments in phytoplankton in coastal waters, by influencing local estuarine conditions and inputs from land and open sea. We examined the relationship between local and large-scale variation by setting up a series of hypotheses and subsequently test which hypothesis best explains the local dynamics in phytoplankton biomass using more than one hundred time series of chlorophyll-a concentrations widely distributed over the globe. The hypotheses including one model that stated that there was no synchronisation in short- and long-term variation at all between the locations (null hypothesis), several models that assumed that there was one common seasonality pattern and/or one long-term trend for all stations, and various models which supposed that the seasonal and interannual variation could be grouped according to specific spatial scales such as watersheds, large marine ecosystems, Longhurst provinces, regional seas and oceanic basins. To check the consistency of our findings, we compared dominant trends as derived from the best models explaining the variance in the time series of the chlorophyll-a concentrations of the coastal sites with the information on the temporal dynamics of phytoplankton biomass at similar spatial scales from other sources, including data derived from satellites and the Continuous Plankton Recorder.

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USING EXPERT JUDGMENTS TO EVALUATE THE PROSPECTS FOR GREAT LAKES CO_2-DRIVEN ACIDIFICATION

The pH of the surface ocean is predicted to drop 0.3-0.4 units by 2100 under steady fossil fuel consumption. Our projections for the Great Lakes suggest a similar decline in pH. However, precise carbonate chemistry monitoring and initiatives have not been implemented, leaving the Great Lakes under-studied with respect to acidification from the increasing absorption of atmospheric CO2. In addition to biogeochemical modeling, integrated with available carbon chemistry data, we interviewed and surveyed Great Lakes scientists. Lacking research on acidification impacts in the Great Lakes, we employed expert elicitation tools to gauge the community's assessment of the importance of CO2 acidification as a stressor and the potential ecological and organismal impacts. Based on a survey of 80 scientists, the community is mostly uncertain about the organismal and ecosystem effects. However, 87% of respondents indicate that CO2-driven acidification is likely. Qualitative interviews with a smaller subset reiterated these findings; the discussion also focused on barriers to studying acidification, specific research priorities, and how to establish a robust monitoring and research program. This interdisciplinary assessment is the first consideration of CO2-driven acidification in the Great Lakes.

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DATA DRIVEN ASSESSMENTS USING LOUISIANA'S COASTWIDE REFERENCE MONITORING SYSTEM

In 1990, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) was passed by Congress which authorized funding for planning and implementing restoration projects in the Louisiana coastal zone. An important component of CWPPRA is a 20-year investment in monitoring the effectiveness of individual projects and providing an assessment of the cumulative effects of projects on the coastal landscape. The Coastwide Reference Monitoring System (CRMS) is a single comprehensive wetland monitoring program that allows for ecological comparisons at site, project, hydrologic basin and coastwide scales. The CRMS network contains 390 1-km2 sites each monitoring a consistent suite of water, vegetation, soil, and landscape parameters at multiple temporal frequencies. To handle the breadth of data collected in this large monitoring program, CRMS developed analytical teams comprised of scientists and information technology specialists. The teams work together to develop analytical products that are based on the needs of the natural resource user community and deliver data in a spatially enabled web environment. Frequent interactions between the analytical teams and the data delivery team ensure that data and analytical products are disseminated in a timely fashion and in a user-friendly manner. The CRMS analytical teams developed indices (i.e., floristic quality, hydrologic, and submergence vulnerability) that are presented in CRMS report cards. The report cards incorporate the indices and land-water analyses to assess the effects of restoration projects at multiple scales. This talk will present the development of the CRMS indices and the multi-scale assessments available through the CRMS report card. The CRMS report cards are available on the CRMS website and are generated "on-the-fly" so that assessments are based on the most current data (http://www.lacoast.gov/crms).

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ADAPTION OF THE DREDGING STRATEGY TO REDUCE IMPACTS ON THE TWAITE SHAD

The Twaite shad is one of the protected species in the estuaries of the Elbe and the Weser in Germany. On the part of nature conservation organisations it is expected, that maintenance dredging activities in the fairway of the estuaries, that are used and enlarged as main shipping routes, might have negative impacts on the reproduction and the life – cycle of the Twaite shad and should therefore be restricted. With the aim to setup an integrated dredging strategy, that takes into account the interests of shipping as well as nature conservation aspects, investigations on impacts on the Twaite shad due to maintenance dredging activities are presently carried out by the Federal Water and Shipping Authority Bremen. In general impacts on the specie can be caused due to levelling and settling processes, changes in water quality such as a dredger induced increase in turbidity or a decrease of oxygen, disturbance of the migration behaviour or spawn activities due to acoustic noise (barrier effect) and negative influences on the food supply. Based on an analysis of the hydrologic and morphodynamic characteristics and maintenance dredging activities in the estuaries and a monitoring of spawning areas as well as on the presence and distribution of eggs and larvae the following questions are discussed: What function do the estuaries have in the life –cycle of the Twaite shad? At what time does spawning take place and where are the eggs and larvae? What impacts do dredging activities might have on the reproduction of the Twaite Shad? What is the conflict between shipping demands and conservation purposes of the Twaite shad? What alternatives in the dredging strategy are possible to reduce impacts and do the monitoring results confirm it?

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BIOGEOGRAPHIC PATTERNS OF OYSTER REEF EFFECTS ON BENTHIC MICROALGAL BIOMASS AND COMPOSITION

Oyster reefs couple the water column and sediments, affecting the transport and transformation of nutrients and carbon in estuaries. Benthic microalgae (BMA) are important estuarine primary producers, playing significant roles in estuarine biogeochemistry and food web dynamics. Intertidal oyster reefs and adjacent intertidal flats were sampled for BMA seasonally for a year at 12 sites on the US Atlantic and Gulf of Mexico Coasts. Biomass and community composition were determined by spectrophotometry and high performance liquid chromatography, respectively. Oyster reef sediments were generally found to have higher BMA biomass than reference sediments in reefs in Florida, Georgia and South Carolina, but to a lesser degree in North Carolina. Seasonal patterns in BMA biomass were variable, with winter maxima at many sites. Preliminary analysis of diagnostic photopigments suggested that benthic microalgal community composition is dominated by diatoms both in oyster reef and reference flat sediments. BMA are known to contribute to the "benthic filter", reducing fluxes of nutrients from sediments into the water column. Experiments are ongoing assessing the efficacy of the benthic filter in nutrient-rich oyster reef sediments. Research on oyster reef impacts on estuarine biogeochemistry should include consideration of the role of BMA as transformers and transporters of nutrients and carbon.

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INVERTEBRATE AND FISH RESPONSES TO EELGRASS AND OYSTER RESTORATION IN A SAN FRANCISCO ESTUARY LIVING SHORELINES PROJECT

The San Francisco Estuary has historically supported a high diversity of fish and aquatic invertebrates. Intertidal habitats with complex physical structure are considered especially productive, providing foraging and shelter opportunities for multiple life stages. This research is being conducted to monitor the response of these populations to the restoration of intertidal habitat including eelgrass (Zostera marina) and native oyster (Ostrea lurida) in the Estuary. The CA Coastal Conservancy's San Francisco Bay Living Shorelines: Nearshore Linkages project is the first project in the Estuary to implement these intertidal habitat restoration techniques at a scale large enough (30m x 10m plots) to provide quantifiable physical results in addition to biological results. Living shorelines have been used throughout the world to reduce physical impacts on shorelines, while simultaneously providing habitat to intertidal invertebrate and fish species. Quarterly invertebrate and fish monitoring was conducted in the restoration plots for four rounds prior to oyster restoration (Oct 2011- July 2012) and has continued after restoration (July 2012-current). Quarterly monitoring has been conducted for seven rounds prior to eelgrass restoration (Oct 2011-Apr 2013) and has continued after restoration (April 2013- current). Monitoring is conducted using a series of traps, seines, and vacuum sampling. Preliminary results have shown a trend of increase in species richness and abundance within the restoration plots compared to the control plots. We have observed a shift from a predominance of mudflat species (e.g., mud-flat crab (Hemigrapsus oregonensis)) to species that have been shown to use eelgrass and oyster habitats as nursery or foraging grounds (e.g., juvenile Dungeness crab (Metacarcinus magister)). This monitoring will further help to determine the relative and interactive effects of adding eelgrass and oyster reefs to restore habitat structure.

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SEASONAL VARIABILITY IN SEDIMENTATION AND HYDRODYNAMICS WITHIN A HYPERTIDAL SALT MARSH CREEK

Current empirical data available to characterize the far field effects of energy extraction on sediment processes in macrotidal zones is lacking the seasonal component, specifically winter conditions. The purpose of this research is to determine the seasonal variability in hydrodynamics, sediment characteristics and sediment behaviour in a tidal creek and salt marsh system. Sediment deposition, suspended sediment concentrations, current velocities and surface samples were collected in the Bay of Fundy at Kingsport marsh at approximately 6 week intervals from May 2012 to June 2013. Data were collected at four stations in the form of a transect perpendicular to the channel; the four stations being the creek, marsh bank, marsh edge and marsh surface. A high resolution topographic survey of the channel was conducted four times over the study period to monitor seasonal changes in elevation. Deposition and concentrations were highest in the creek and lowest on the marsh surface and edge, with deposition being on average 3 times higher in the creek than on the marsh. Velocities showed a pattern of being more flood dominant closer to the creek and less flood dominant with increasing distance from creek. Sediments in the creek were coarser than at all marsh stations, with no great variability between marsh stations. In the creek, grains were finest in May 2012, increasing in size to a maximum in August and returning to fine grains in the following months. On the marsh, velocity and overall sediment supply exerted the most influence on deposition, while in the creek, suspended sediment concentration and precipitation dominated. Data collected are also being used for validation of a hydrodynamic and sediment transport model in a companion project. An understanding of relationships between factors controlling deposition and their seasonal variability will lead to a better understanding of muddy intertidal systems and their potential to change due to anthropogenic activities.

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RANGIA CLAM DECLINE IN LAKE PONTCHARTRAIN: EFFECTS OF ENHANCED STORM SURGES DUE TO SEA LEVEL RISE, AN INCREASE IN THE FREQUENCY AND SEVERITY OF HURRICANES AND MARSH AND BARRIER ISLAND LOSS

Rangia cuneata is a clam found in low salinity zones of Atlantic and Gulf of Mexico estuaries. It was abundant in Lake Pontchartrain, a large and shallow oligohaline estuary, located north of New Orleans. In 1990, the concern over Rangia decline from pre-1954 levels lead to the cessation of shell dredging, which began in 1933. Recovery to 1954 levels occurred by 1998 and clam abundance was regarded as an indicator of habitat quality and restoration success. However, large clams were absent from areas with saltwater intrusion from a navigation canal, the Mississippi River Gulf Outlet (MRGO). There was an abrupt decrease in abundance from April 2001 through December 2003 after an extreme drought and increased salinity from a 1997-2001 El Nino Southern Oscillation Shift. Abundance increased by April 2005 but decreased by November 2005 due to Hurricanes Katrina and Rita. Since Katrina (2005-2012), densities have remained low despite the closure of the MRGO in 2009. Although some intermittent periods of recovery have occurred, severe declines were noted after major hurricanes. These declines appear to be driven by global climate change which, in addition to subsidence, has increased sea-level and resulted in storms with more detrimental surges. These intense surges resuspend sediment which buries clams and abruptly increases salinity and lowers dissolved oxygen. Salinity stratification persists after storms and causes anoxia and hypoxia in bottom water. Since 1995, the intensity and frequency of storms has increased. Loss of marsh and barrier islands occurs with each successive storm and overtime has increased the size of surges reaching the Lake. Periodic operation of a Mississippi River flood diversion, the Bonnet Carre Spillway, has abruptly decreased salinity and contributed to eutrophication which exacerbates the adverse effects of surges. Surges have also decreased the abundance of other benthos, resulting in a reduction of essential fish habitat.

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NUTRIENT AND SEDIMENT EFFECTS ON OLIGOHALINE MARSH PLANTS IN THE MISSISSIPPI RIVER DELTA

The Mississippi River Delta comprises approximately 40% of the coastal wetlands in the conterminous United States, but has experienced more than 80% of the wetland loss due largely to flood control levees that have hydrologically isolated the lower River from the adjacent wetlands for a century. Thus, reconnecting the River to the wetlands through diversions is one approach being used to reduce the rate of wetland loss. However, the diversion structures currently operating in this manner were originally designed to deliver freshwater rather than sediment. Furthermore, nutrient concentrations in the River water have increased during the past half-century as a result of agricultural intensification in the upper watershed. The goals of this study were to identify the effects of selected nutrients on structural and functional components of an oligohaline wetland plant community, and to determine if current diversion-sediment loading rates effectively reduce any such impacts. We collected 60 intact marsh sods from a Sagittaria lancifolia dominated wetland near Madisonville, Louisiana, and transported them to a greenhouse at Louisiana State University. The sods were assigned one of six nutrient additions (ammonium, nitrate, phosphate, sulfate, all four nutrients in combination (combo), and no nutrient addition) in combination with or without sediment in a completely randomized design. Each treatment was applied monthly to five replicate sods for two years, during which time we measured their effects on above- and belowground biomass, plant species composition, pH, and conductivity. Nitrate, ammonium, and combo increased aboveground biomass while sulfate decreased it. Phosphate had no significant effect. Sediment tended to increase aboveground biomass ($p \leq 0.07$), but did not significantly interact with any nutrient. None of the treatment applications had any effect on the number of new species, total species numbers, or belowground biomass.

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AN ECOGEOMORPHIC FIELD AND HYBRID MODELING APPROACH TO PREDICTING A COASTAL WETLAND RESPONSE TO SEA LEVEL RISE

With increasing rates of eustatic sea level rise (ESLR) due to climate change, estuaries worldwide are facing the possibility of conversion to open water if accretion cannot keep pace with sea level rise, especially where upland areas have been modified such that the inland migration of the estuary is prevented. Previous research into sediment elevation

dynamics in Padilla Bay, a National Estuarine Research Reserve in Puget Sound, WA has revealed a mean bay-wide elevation deficit of -0.46 cm/yr since 2002. However, a more mechanistic prediction of the estuary's response to future ESLR should also incorporate non-linear feedback mechanisms between water depth, plant biomass, and sediment deposition. Therefore, we used the field data collected as part of this research (measurements of sediment accretion rates, suspended sediment concentrations, and above- and belowground eelgrass biomass) to build and calibrate a marsh equilibrium model (MEM), developed elsewhere but applied here for the first time to this eelgrass-dominated intertidal habitat. We then coupled the MEM with a relative elevation model (REM) which has previously been applied here, to create a hybrid model that combines each model's strengths in mechanistically simulating above- and belowground processes, respectively. The model predicts elevation change under various ESLR and suspended sediment scenarios. We used an 11-year elevation change dataset obtained from an extensive surface elevation table (SET) network in Padilla Bay for model validation.

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USING SIMPLE MODELS TO UNDERSTAND ESTUARINE MACROALGAE BLOOMS

Nuisance blooms of ephemeral marine macroalgae have been documented in estuaries worldwide, and their increasing occurrence in many regions is a cause for public concern. However, despite many years of research with laboratory and field-based experiments and monitoring, the processes controlling such blooms are still often unclear. Blooms of sea lettuce (Ulva spp.) of varying intensity and seasonality have been occurring since at least the early 1990s in Tauranga Harbour (New Zealand), a shallow, barrier-enclosed, meso-tidal lagoon. We use relatively simple, mechanistic / process-based mathematical models to examine the interactions of sea lettuce abundance, physiological status, water column nutrients and related environmental parameters. Evaluating the model for both short-term equilibria as well as longer-term dynamic simulations, we examine the relative importance of environmental and population factors on timescales from days to decades in triggering and sustaining the observed blooms. Model development and validation is based on over 20 years of monitoring data as well as observations from a recent field campaign. The latter provides previously unavailable data on the spatial (distinctive subregions within the estuary) and temporal (tidal to seasonal) variability of water column nutrients as well as on the drifting population of sea lettuce (estimates of biomass standing stock and flux between subregions). One of the key components of most macroalgae growth models is the dependence of cell-internal nutrient quota on external nutrients. A short-term equilibrium solution to one of the commonly used mathematical descriptions of this process has been found, allowing for the direct evaluation of this factor in addition to the more common evaluation as part of a coupled system including other growth and decay processes.

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CLASSIFICATION AND ENVIRONMENTAL CORRELATES OF TIDAL WETLAND VEGETATION: IMPLICATIONS FOR ECOLOGICAL RESTORATION AND MONITORING

Coastal and estuarine tidal marshes in Atlantic Maritime Canada have sustained losses estimated at 70% of their historical distribution, prompting restoration efforts. Throughout eastern North America, these habitats show conspicuous zonation attributable to biotic interactions between plant species and differential tolerance of salinity and flooding. Previous descriptions suggest plant communities in Atlantic Canada are similar to those found in New England, which have been extensively studied. Many tidal wetland restoration projects, however, involve both salt marsh vegetation and brackish/freshwater influenced vegetation higher in the tidal frame, which has been poorly documented in eastern Canada. The goal of this study was to numerically classify tidal marsh vegetation in Nova Scotia, and to determine the multivariate relationships between plant species composition and environmental factors. Vegetation communities were sampled from eight tidal wetlands designated as reference sites for paired tidal wetland restoration projects. Study sites spanned a wide tidal range encompassing of macrotidal to microtidal environments. Cluster analysis revealed seven distinct plant communities related to gradients of inundation duration and salinity. Plant community types were usually dominated by a single graminoid species, similar to those found farther south in New England. An additional three brackish communities that were not previously described in Nova Scotia were identified, dominated by Juncus balticus-Festuca rubra, Carex paleacea and Spartina pectinata. Redundancy analysis showed continuous variation among these community types and highlighted key environmental variables related to plant community patterns. These analyses characterize environmental correlates of plant communities and provide a baseline for further restoration work, allowing for better predictions of ecological restoration trajectories in tidal marshes.

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STUDENT/MENTOR INVESTIGATION OF HSC POPULATION DYNAMICS SERVES AS A VEHICLE FOR SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS (STEM) ADVANCEMENT THROUGH COLLEGE/HIGH SCHOOL COLLABORATION

Populations of the Atlantic horseshoe crab (HSC), Limulus polyphemus, are distributed across the Atlantic coast of North America, from Maine to the Gulf of Mexico. They have great ecological and economic importance and can be found within many estuaries along the eastern coast of North America as well as in the contiguous continental shelf areas. Investigating population dynamics of the HSC with faculty mentors offers undergraduate and HS students an opportunity to participate in a broad spectrum of STEM activities through the Center for Estuarine, Environmental and Coastal Oceans Monitoring (CEECOM) at Dowling College. Since 2007 faculty at CEECOM and the Research in Science & Engineering Program advisor at Sayville High School have collaborated on projects involving local HSC populations to support and promote authentic research. Principal Investigators guide the students to design their individualized Project Plan from the conception of a problem through state of the art field and lab techniques. Students are engaged in or exposed to GIS, laboratory techniques in molecular ecology and statistical analyses depending on their individual roles, and will ultimately contribute to finding answers to a much larger question. End products are student presentations at public symposia and the production of a manuscript for publication. Description of recruitment, mentor-student interviews and research activities are discussed here.

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RATE OF PRE-WINTER TEMPERATURE DECLINE AND THE EXOGENOUS AVAILABILITY OF LONG CHAIN POLYUNSATURATED FATTY ACIDS: IMPLICATIONS FOR JUVENILE HARD CLAM SURVIVAL IN THE TEMPERATE ZONE

Mortality can claim high numbers of juvenile hard clams, Mercenaria mercenaria, during and after cold winters in the temperate climate. Prior investigations have demonstrated that poikilotherms, like M. mercenaria, remodel cell membrane lipids in an effort to maintain proper cell function through declining autumn temperatures. The ratio of unsaturated to saturated fatty acids affects the collective fluidity of cell membranes; a higher ratio creates a more flexible phospholipid bilayer through declining temperatures. It has been suggested that the ability of M. mercenaria to synthesize polyunsaturated fatty acids to optimize the unsaturation index in response to environmental factors exists but is limited. A recent study demonstrates that juvenile M. mercenaria deprived of dietary DHA during a rapid temperature drop, failed to keep pace with increasing cell membrane viscosity. Other cell membrane fluidizing strategies are discussed.

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PLOIDY ANALYSIS OF THE BLOOM FORMING MACROALGAL GENUS *ULVA* USING FLOW CYTOMETRY IN NARRAGANSETT BAY, RI

Macroalgal blooms occur worldwide, often in shallow areas with relatively low water mixing, and have the potential to cause severe ecological and economic damage. Narragansett Bay, RI is a eutrophic system that experiences summer macroalgal blooms composed mostly of *Ulva compressa* and *Ulva rigida*. All *Ulva* species have isomorphic, biphasic lifecycles, and the relative contribution of the haploid and diploid life history stages to bloom formation is poorly understood. We first developed flow cytometry protocols to assess the ploidy of individual *Ulva* thalli. We then assessed the ploidy levels of *U. compressa* and *U. rigida* populations from three sites in Narragansett Bay, RI in June, July, and August 2013. For each species during each month we sampled, both haploid gametophytes and diploid sporophytes were present. However, field populations in June and August indicated a clear dominance of gametophytes for both *U. compressa* and *U. rigida*. Our results were less straightforward for July, with a dominance of gametophytes for *U. rigida* and sporophytes for *U. compressa*. Our data match modeling predictions of

gametophyte dominance when the phases are ecologically identical. We plan to continue assessing ploidy ratios as blooms decrease during the fall months, and to couple these data with overall biomass estimates to predict the relative abundance of ploidy levels during peak bloom and non-bloom scenarios.

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THE INTERACTION OF CATCHMENT FLOWS, SALINITY INDUCED FLOCCULATION AND RIVER REACH HYPSOMETRY HAVE PROFOUND EFFECTS ON THE FATE OF ORGANIC MATTER AND NUTRIENTS IN SEDIMENTS ALONG THE ESTUARINE CONTINUUM IN RIVERINE ESTUARIES OF NSW AUSTRALIA

Across the estuary continuum, salinity generally increases from the upper reaches to the mouth, whereas light attenuation due to chlorophyll, suspended solids and colour decreases toward the mouth due to flocculation and dilution with oceanic water. River bed morphology (hypsometry) also changes along the estuarine continuum where shoal to channel surface area ratios decrease from the upper estuary (mostly deep and channelized) to the lower estuary (mostly shallow and shoaled). We demonstrate that the location of major depositional zones for allochthonous and autochthonous OM (corresponding to salinities of 2-5 PSU) in these systems are spatially and temporally plastic due to their dependence upon seawater exchange and size and duration of catchment flows. We also demonstrate that the specific location of major depositional zones along the estuarine continuum (upper vs middle vs lower reaches) can have profound effects on the way nutrients, oxygen and carbon are cycled between the sediment and the water column. During high flows, OM is delivered to the shoal dominated lower estuary where BMA productivity controls nutrient cycling by actively taking up nutrients and carbon from both the water column and sediment. In contrast during low flows, OM is delivered to the deeper channel dominated upper and middle estuary reaches where BMA productivity is mostly limited to the shallow channel banks. In the deeper channel heterotrophic microbes dominate OM and nutrient cycling between the sediment and the water column.

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CHANGES IN SOIL ORGANIC CARBON STORAGE IN SALT MARSHES OF THE BAHíA BLANCA ESTUARY (ARGENTINA), FROM 1967 TO 2005

Salt marsh soils commonly store large amounts of organic carbon because of a high plant biomass production and slow decay rates due to anoxic conditions. Under a rising sea level, salt marshes with adequate sediment input can vertically accrete to match the rise in water level, and the organic carbon content in soils, especially in deeper layers, is a measure of the long-term carbon storage. In this work we describe a recent change in carbon storage at the Bahía Blanca estuary, a highly dynamic coastal environment in the South Western Atlantic. In the study area, the relative sea level reached around 6 m above present about 6000 years ago, and the late Holocene falling trend has resulted in wide low-lying coastal terraces, inherited from the former estuarine dynamics. Through the quantification of recent changes in land cover, surface elevation profiles, and soil surveys, we estimated that 21.5 km^2 of *Sarcocornia perennis* marshes converted to mudflats between 1967 and 2005, and 3.4 kg C m^{-2} were lost from the soil organic carbon pool. The observed marsh loss and the erosion of soft sediments are in agreement with the present rising trends in relative sea level. The coastal platform presently occupied by *Sarcocornia perennis* marshes derives from marine deposits that formed during the late Holocene, under a slightly higher relative sea level. Under the current conditions, these low lying coastal landforms became relict and their erosion may be accelerated by the recent rise in sea level. A Holocene relative sea level higher than present characterized most coastlines of the southern hemisphere. Although our work is geographically restricted, we provide a description of a transgressive coastal system where salt marsh soils act as a net source of organic carbon. Given the role that wetlands soils play in the global carbon cycle, further work is needed to evaluate the potential to extrapolate the observations to a broader scale.

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BENTHIC COMPOSITION AND BIOGEOCHEMICAL CYCLING ON CORAL REEFS: IMPLICATIONS FOR OCEAN ACIDIFICATION

Our current knowledge of how ocean acidification (OA) impacts marine species is based on results from static mesocosm incubations and an assumption that shallow regimes acidify at the same rate as the open ocean. A recent appreciation for substantial spatio-temporal variability in seawater pH in coastal systems, particularly on coral reefs, challenges our understanding of species tolerance limits and physiological contributions to current heterogeneous nearshore environments. Despite raised concern over the ability of coral reefs to survive in a 'high CO_2 world', we still do not understand how biogeochemical feedbacks from resident organisms drive natural variability of carbonate chemistry, which may affect ecosystem resilience to global change. Here, we examined how the species composition of bottom-dwelling organisms affects seawater chemistry across six atolls in the Central Pacific via photosynthesis/respiration and precipitation/dissolution of $CaCO_3$ using benthic isolation tents. We identified key benthic reef taxa that contributed significantly to the measured amplitude of diel fluctuations in seawater pH and O_2 under the tents. A reduction in the aragonite saturation state (Ω) was observed in tents with elevated dark microbial respiration. The faster generation times of marine microbes, fueled by dissolved organic matter (DOM) released from primary producers, lowered Ω after 24 hrs. Carbon sequestration via productivity can lessen the effects of OA in other nearshore ecosystems, but the identity of primary producers and their respective ability to fix and retain DOM may indicate positive or negative feedbacks, via microbialization, to the concentration of inorganic carbon species. Knowledge about species specific physiological rates and relative abundances of key taxa whose metabolism significantly alters carbonate chemistry may give insight to the ability for a reef to buffer against, or exacerbate the impact of ocean acidification on benthic organisms.

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RESTORATION OF A COASTAL ESTUARINE ECOSYSTEM: A TOOL TO INCREASE HYDROLOGIC STORAGE CAPACITY AND ECOLOGICAL RESILIENCE

Salmon River watershed is located on the north-central Oregon Coast, USA. The basin is 195 km2 in size, with an 800 hectare estuary that extends to river kilometer 6.5. The basin has a diverse ownership and management: United Nations Biosphere Reserve, US Forest Service Cascade Head Scenic Research Area (Congressional designation), The Nature Conservancy-headlands, private industrial forest-uplands, Oregon State Parks and rural residential along the lower reaches of main-stem Salmon River. Agricultural, residential and commercial development in the mid 1900's impacted the intertidal portion of the Salmon River estuary. All but one low marsh system was altered to prevent tidal inflow and control freshwater outflow. The estuary was restored incrementally from 1978 to 2012. This restoration has resulted in 250 hectares of the approximately 800 hectare estuary restored and approximately 30km of connected tidal channels over 34 years. The last remaining dam is United States Highway 101. Nearly the entire estuary is now restored to a natural, historic tidal regime. Sinous tidal channels provide rearing grounds for anadromous fish. Tidal channels provide a significant salinity gradient. Anadromous fish are using these areas for a greater extent of time and growing at increased rates. Restoration has resulted in near complete physical and biological return to historic conditions. Improving ecological resilence. Results indicate that the re-established tidal channels and associated marsh area provides increased flood capacity during peak tides coupled with storm surge, resulting in less up stream flooding impacts on rural residential properties. Modeling for this region indicates increased frequency and/or intensity of the wet season, congruent with increased tidal inundation. The temporal and spatial distribution of flooding as a result of various sea level rise scenarios may be mitigated by restored tidal systems.

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SPATIAL VARIABILITY IN NUTRIENT AND SEDIMENT LOADS DUE TO CLIMATE CHANGE IN CHESAPEAKE BAY WATERSHEDS

In 2010, the EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL), a federal "pollution diet" that sets limits on the amount of nutrients and sediment in order to meet water quality goals. To ensure the TMDL is met, the jurisdictions use Watershed Implementation Plans (WIPs), two-year milestones, monitoring, and an integrated modeling system to track and assess progress toward completing the restoration actions. The Chesapeake Bay Program (CBP) integrated models include simulations of the airshed, watershed, estuary, and living resources. These integrated models assess effects of current and proposed watershed management on changes in nutrient and sediment loads delivered to the Bay, and the effect those changing loads have on water quality and living resources. In order to obtain and then continue to meet water quality standards, the CBP and its partners must understand the consequences of climate change and consider climate change as an integral part of decision-making. Effects of climate change, such as sea level rise and increased temperatures, have already been recorded in the Chesapeake region and throughout the world. Other possible impacts of climate change on the Bay include lower dissolved oxygen levels, more precipitation, and changes in wildlife abundance and migration patterns. This study uses the Watershed Model to investigate the fate of hydrology and nutrient and sediment transport as part of an ongoing climate change study. The HSPF (Hydrological Simulation Program Fortran) Watershed Model, the Chesapeake is divided into 368 land segments. Each land segment has specific natural characteristics, nutrients applications, and land uses. There are thirty land-uses, 25 pervious and 5 impervious, such as farmland with high-till and manure application. The analysis examines the spatial variability in the impacts of climate change at Chesapeake Bay watersheds.

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LARVAL DISPERSAL AND POPULATION CONNECTIVITY AMONG A NETWORK OF MARINE RESERVES

Larval dispersal and population connectivity influence marine metapopulation dynamics and the success of marine reserve networks. We used a biophysical model to assess the relative importance of spawning location, spawning time, adult demography, and larval biology on dispersal of eastern oyster (*Crassostrea virginica*) larvae and connectivity among a network of no-take reserves. Particles (i.e., virtual larvae) were released from reserves in a shallow wind-driven estuary during primary and secondary spawning peaks over a 5 year period. The location (i.e., natal reserve) and timing of spawning relative to physical processes, particularly frequency of wind reversals, were the dominant drivers of dispersal and connectivity patterns. To a lesser extent, larval behavior (i.e., ontogenetic depth regulation) and mortality modified dispersal and connectivity, whereas spatiotemporal variability in adult reproductive output was only marginally significant. Over a 21 day larval duration, particles dispersed a mean distance of 2 to 75 km over an area covering 2 to 471 km^2. Local retention of passive surface particles was typically small in magnitude (median <1%) such that immigration exceeded local retention (i.e., reserves demographically "open"). Particle behavior increased local retention by an order of magnitude doubling the proportion of demographically "closed" reserves. Over 5 years, ~40% of the 90 possible inter-reserve connections occurred, but the magnitude of connections was highly variable (<1 to 99% of particles) and often asymmetrical. The importance of spawning location on both connectivity and demographic rates suggests that source-sink dynamics may be an important component of this estuarine metapopulation.

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DID ACUTE DROUGHT AFFECT ECOSYSTEM DEVELOPMENT IN A RESTORED BRACKISH MARSH?

Extreme events like droughts can dramatically alter ecosystem functions – the effects may be most profound in transitional (e.g., brackish) habitats or in the early-successional stages in developing ecosystems, such as recently restored habitats. As part of a long-term wetland restoration monitoring program, we were able to document the effects of the 2011 exceptional drought in Texas and to follow near-term recovery of ecosystem functions in restored brackish marshes in the NW Gulf of Mexico. As a result of the year-long drought, salinities increased to three-times greater than normal for several months, but then returned to normal (< 10 ppt) in 2012. Immediate effects on emergent plants were minimal, but lower plant biomass in 2012 suggested long-term drought effects. Drought and the corresponding high salinity had dramatic and long-term effects on submerged aquatic vegetation (SAV). The invasive Eurasian milfoil (Myriophyllum spicatum) was essentially eradicated during the drought and remained rare throughout 2012. Drought effects were less dramatic for native Ruppia maritima, which slightly increased in biomass in 2011 and 2012, possibly due to a release from competition from Myriophyllum. Drought may have caused a long-term loss of total SAV biomass and a possibly beneficial shift in species composition by disproportionately impacting the invasive species. Effects on phytoplankton were immediate during the drought, with a shift in community composition from diatom- to cyanobacteria-dominated. Many aquatic fauna, including snails, grass shrimp, and fish, declined dramatically during the drought. This may have been a direct response to salinity, as well as a trophic response to the substantial changes in the producers at the base of the food web. The findings from this study, which include pre-, during-, and post-drought surveys, will provide insight into how acute drought affects ecosystem development in restored brackish marshes.

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MEIOFAUNAL ANALYSES OF SEDIMENT CORES TO INVESTIGATE SALTMARSH DEVELOPMENT RELATIVE TO CHANGES IN SEA LEVEL

Coastal saltmarshes, valued habitats for conservation and flood defence, are being lost at 1% annually, and are threatened by increased rates of sea level rise (SLR). This research tests two competing hypotheses of saltmarsh formation related to SLR. The accepted hypothesis (1) is development from low to high marsh on accreting sediment facilitated by a succession of plant species, and which is threatened by SLR. The competing hypothesis (2) is that SLR causes most saltmarsh development by migration landward and succession from high marsh toward mid marsh which largely keeps pace with SLR by compensatory accretion. The developmental histories of saltmarshes in England and Scotland are examined in sediment cores for variations in the meiofauna, especially benthic foraminifera, which like the plants show a vertical zonation but fossilise well. Britain is undergoing isostatic uplift in the North and subsidence in the South. The results from two representative sites are presented: Loch Riddon (W Scotland) where uplift of 1.6mm.y-1 has lead to a local sea level fall, and Tollesbury (SE England) subsiding at 1.5 mm y-1. At both sites a clear surface zonation was apparent, with agglutinated foraminifera on high marshes and calcareous species dominating the low marshes and flats. The assemblages in the Loch Riddon cores indicate a succession from low to high marsh, consistent with saltmarsh surface rising with respect to sea level, but explicable by isostatic uplift rather than facilitated sediment accretion. Two cores from Tollesbury (2.5m and 5m deep) contain only agglutinated foraminifera, indicating no significant succession and no underlying low marsh assemblage, supporting hypothesis 2. Most saltmarshes are on subsiding coasts partly because SLR was the main means of their formation. Future SLR may not necessarily stop most saltmarsh development since facilitation succession leading to accretion rates in excess of SLR (hypothesis 1) is unimportant.

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CLASSIFYING SALTMARSH PONDS AND FISH ASSEMBLAGES AT THE ARANSAS NATIONAL WILDLIFE REFUGE, TX

In estuarine systems, inundation regime plays a vital role in shaping the physical and chemical characteristics of saltwater ponds. Along the Texas Gulf coast, saltwater ponds are scattered across the coastal marsh landscape, with each pond possessing a varying degree of hydrological connectivity to adjacent estuarine waters. The timing, frequency and magnitude of connection events can directly influence both the abiotic and biotic components of the ponds. To determine how the degree of hydrological connectivity impacts these systems at the Aransas National Wildlife Refuge (ANWR), we collected physical (e.g., edge type, soil cores) and biogeochemical (e.g., pH, dissolved oxygen, nutrient concentrations) data to characterize pond structure during the summer of 2013. In addition, fish assemblage data was collected via seining and minnow traps to determine what, if any, affect pond conditions and the timing of hydrologic connection events have on the composition of fish assemblages in ponds. To date, most efforts to understanding how altered hydroperiod impacts the marsh complex at the ANWR have focused on the marsh platform and not the saltmarsh ponds. Our focus here on the saltmarsh ponds, is an important step to linking hydrologic drivers to the greater marsh ecosystem, food web dynamics and the overall coastal management practices in the region.

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BENTHIC CONTRIBUTION TO ESTUARINE SILICA BUDGETS : RESULTS FROM MEASUREMENTS AND MODELLING

Increasing the understanding of silica (Si) cycle at land-sea interfaces is necessary to quantify their buffering capacities and to elucidate their role in coastal zone biogeochemistry and ecosystem functioning. Sediments cores were taken at six sites and four seasons along the Elorn and Aulne estuaries which discharge into the Bay of Brest (France), and vertical porosity, amorphous silica (aSiO2) and silicic acid (Si(OH)4) profiles were measured. A diagenetic model adapted from Khalil et al. (2007) was then used to fit the measured profiles of aSiO2 and Si(OH)4. This model allowed quantifying benthic Si fluxes, e.g. aSiO2 deposition fluxes that are difficult to assess through direct measurements, and to estimate their seasonal contribution to benthic-pelagic coupling. The results showed that sites sampled along the Elorn and Aulne estuaires constituted significant net deposition areas year round, with negligeable reprecipitation. Deposition was particularly high during winter (upstream) and summer (midstream and downstream). However, as benthic Si fluxes were low compared to riverine aSiO2 fluxes during winter, the total Si export to coastal waters dominated. In contrast, in summer, Si(OH)4 export from the sediment was generally observed as a result of enhanced benthic recycling and bio-irrigation accounting for >60%. During extreme summer conditions, estuarine internal processes, e.g. primary production, dissolution and benthic Si fluxes, surpassed river fluxes in magnitude. Overall we concluded that the estuaries Elorn and Aulne are efficient filters of Si, retaining about 50% of aSiO2 deposited at the sediment-water interface, but with transient export occurring during winter floods.

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CRAFTING A MECHANISTIC FUNCTIONAL INDICATOR: EXAMINING ALLOMETRIC RESPONSES OF A MODEL SPECIES, *CAPITELLA TELETA*, TO COMBINED LEVELS OF DISSOLVED OXYGEN AND TEMPERATURE

Resource managers and scientists require indicators with clear connections to ecosystem function, especially where critical environmental issues, such as hypoxia and climate change, are concerned. Macrobenthic population responses to stressors should entail mechanistic links involving bioenergetic capacities of individuals to respire, ingest food, and allocate energy. Extensively studied as a model species, *Capitella telata*, is a key tolerant opportunistic indicator of stressed benthic habitats that is easily cultured. Stock cultures of *C. telata* obtained from J.P. Grassle are currently being used to examine allometric responses to combined levels of dissolved oxygen and temperature. Autecological effects, including aerobic and anaerobic respiration, tropho-energetic parameters, and growth as well as degrowth rates will be examined at various combined levels of dissolved oxygen (DO) and temperature. Preliminary data reveal interesting patterns in the body-size responses of *C. telata*. Respiration rates are strongly tied to body size for this species. Moreover, a pattern in the parameters of the allometric respiration curves relative to DO exposure level is emerging: the exponent decreases and the constant scaling factor increases as exposures range from hypoxic to more normoxic conditions at 20° C. As expected, allometric respiration curves are elevated at warm temperatures. Interestingly, allometric respiration curves are also lower for subjects experiencing long-term exposures. Causal observations suggest that large subjects lose relatively more mass than small subjects during hypoxic exposures. By providing relevant information for an existing mass balance model, this study will allow further insights into how autecological processes interact to elicit indicator responses. Moreover, results will facilitate the crafting of an incipient resource management tool for assessing potential losses to ecosystem services, fisheries production and coastal health.

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FLOCCULATION UNDER THE EFFECT OF CURRENTS AND WAVES

Good understanding and predictions of sediment transport are needed for improved management of coastal zones and estuaries. However, sediment dynamics can be complicated by (i) the waves-currents combination, and (ii) fine particulate material resulting in processes influencing sediment size and settling. The present work seeks to increase our understanding of the flocculation process under the combined effect of currents and waves. We will use a set of field observations at the entrance of the Dee Estuary, in Liverpool Bay, United Kingdom, between 12 February 2008 and 9 March 2008. The observations consist of suspended particulate matter concentration, grain size, current velocities and turbulence properties near the sea bed. Three distinct regimes were found: currents-only, combined waves and currents, and wave dominated. During the currents-only regime, flocculation is clearly visible with floc aggregation and breakup during periods of low and high turbulent stress respectively. The combination of waves and spring tides leads to wave-height-dependent-behaviour. Waves with significant height of about one meter seem to enhance the breakup process of sediment previously suspended by currents. The breakup process is almost dominant when waves are higher than one meter and small flocs are found even with low turbulent stress. A third regime is identified as wave-dominant during neap tides with current speed less than 0.25 m/s and waves of 1-2 meters height. In this regime the wave effect takes large sediment into suspension at the same time as small particle sizes from the floc breakup. According to the observations, the combination of currents and waves has an important effect on the flocculation and suspension processes and need to be taken into account in sediment transport modelling studies. An implementation of the observed behaviours will be tested in a three dimensional hydrodynamic model coupled with a wave model and a sediment transport module.

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HABITAT-RELATED BENTHIC MACROFAUNAL ASSEMBLAGES OF THE SOUTHERN CALIFORNIA BIGHT 1994-2008

Understanding habitat factors that naturally differentiate biotic assemblages is the first step in setting reference expectations for biotic resources in any ecosystem, and the development of condition indices. Data from four benthic surveys of the Southern California Bight conducted from 1994-2008 were combined and used to assess the number and distribution of habitat-related benthic macrofaunal assemblages. Q-mode cluster analysis was applied to 1436 samples from estuaries, bays, continental and island shelves, and the continental slope to depths of 1000m. Site groupings were tested for differences in six habitat factors (sediment grain size, depth, salinity, latitude, longitude, and total organic carbon). Three

habitat-related macrofaunal assemblages were identified in (1) bays and estuaries, (2) the continental and island shelves, and (3) the continental slope. All three assemblages had sub-assemblages structured primarily by sediment grain size and depth that were widely distributed throughout the Bight. Benthic abundance and diversity were greatest in the mid-shelf sub-assemblage, conforming to predictions for benthic assemblages in regions of upwelling. Within the 500 km of coastline examined, latitude was not an important factor in defining assemblages. The empirically defined points in the depth, sediment grain size, and habitat gradients that differentiate the benthic assemblages can be used to define reference habitats for the development of biocriteria.

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RAPID CHANGES IN RHODE ISLAND SALT MARSH VEGETATION COMMUNITIES IN RESPONSE TO ACCELERATING SEA-LEVEL RISE

New England salt marshes currently face impacts from multiple threats, including increasing rates of sea level rise combined with years of anomalously high tides. If marshes are unable to keep up with rising sea levels, impacts will include vegetation shifts, high marsh ponding, creek sloughing, and eventually, drowning. Two complementary salt marsh monitoring and assessment programs were recently initiated to document how marshes are responding sea level rise in Narragansett Bay, RI. Here, we combine data from these two programs to show that salt marsh vegetation is changing rapidly and dramatically. Spatial patterns across Narragansett Bay were examined using data from the new RI Salt Marsh Assessment (RISMA) program. Recent temporal trends were derived from two salt marshes that are the foci of the National Estuarine Research Reserve System's Sentinel Sites program in Rhode Island. Point-intercept monitoring shows that the salt meadow species *Spartina patens* has decreased significantly over time in both Sentinel Site marshes. This species is being replaced by stunted *S. alterniflora* and unvegetated peat and, if the current trend continues, *S. patens* may be lost from both marshes by 2018. These findings are supported by complementary belt transect monitoring, which we used to document a 48% increase in *S. alterniflora* habitat and concomitant 33% decrease in salt meadow habitat in both marshes in only 2 years. Initial data from RISMA in 2012 indicate that these patterns are occurring throughout much of Narragansett Bay. For example, *S. alterniflora* cover averaged 55% across 18 marshes, and ranged from 77-100% at 5 of these marshes. Our data suggest that salt marshes in Narragansett Bay are showing widespread impacts from sea level rise. With sea levels expected to rise even faster, we predict that salt meadow habitat will continue to decline rapidly as it is replaced by stunted *S. alterniflora* monostands interspersed with unvegetated areas.

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CONTRASTING RESILLENCE OF DEEP AND SHALLOW TROPICAL SEAGRASS COMMUNITIES TO MAJOR CLIMATE ASSOCIATED LOSSES IN NORTH QUEENSLAND, AUSTRALIA

Significant loss of seagrasses occurred in tropical North Queensland following strong La Niña events in 2010 and 2011 and severe Tropical Cyclone Yasi that passed through the area in March 2011. A quarterly assessment program established in 2008 examining seagrass biomass, species composition and area of seagrass meadows was used to assess seagrass changes and recovery. Measurements of seagrass reproductive output, seed banks and experimental examination of capacity for sexual and asexual recovery of the various species were also examined to assess their resillience to impacts. Results found that while seagrass in shallow coastal meadows and in deeper offshore areas both suffered major declines, recovery in the 2 years following loss was markedly different. Significant recovery had occurred for deeper meadows but no recovery for shallow coastal seagrass communities was recorded. All seagrasses were found to have the potential to recover, however this was highly dependent upon the species present, the availability of seed reserves and reproductive strategies employed. The study emphasizes the requirement for a good understanding of inter and intra-specific differences in the resilience and potential for seagrass recovery to predict the consequences of climate change to seagrasses. This is especially important for tropical seagrass meadows where more frequent severe storms and La Niña climate patterns such as those recorded recently in north Queensland are predicted as a consequence of climate change.

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NITROGEN AND CARBON DYNAMICS IN RIVERS OF THE ALTO PARAíBA DO SUL BASIN, SãO PAULO STATE, BRAZIL

Great part of the actual knowledge about nutrients dynamics at terrestrial and aquatic ecosystems comes from studies in temperate forests. Studies in tropical basins, like the Alto Paraíba do Sul Basin, São Paulo, Brazil, are important, since the magnitude of potential flows of elements from terrestrial ecosystems to the rivers, oceans and atmosphere is not well represented in the literature. The Paraíba do Sul River drains the three more economically developed states of the country: São Paulo, Minas Gerais and Rio de Janeiro. Its basin, with nearly 57,000 km^2, is a typical "developed", or extremely altered, subtropical basin. Its population is about 5.3 million inhabitants. Despite its economical and social importance, we don't know much about carbon and nitrogen transport into its rivers and how these are affected by the intense soil use and the water resources management. This work aims to investigate these nutrients dynamics at Paraibuna, Paraitinga and Paraíba do Sul Rivers, both third order rivers, and some first and second order rivers, indirect tributaries of those, both insert at the Alto Paraíba do Sul Basin, trying to understand how changes in the soil use and in the river order interfere in the C and N dynamics. In general, the low DOC, DIC, TDN and inorganic N concentrations found in the first order rivers at the forest and pasture areas, show the low variation of these nutrients, despite changes in the soil use. Forested rivers presented higher DOC (3.3 $mg.L^{-1}$) and TDN (14.2 μM) concentrations than the pasture rivers (2.6 $mg.L^{-1}$ and 13.8 μM, respectively), while these presented higher DIC concentrations than those ones (90.2 μM and 71.2 μM, respectively). Even in the third order rivers, the concentrations found are very low, although we consider the anthropic pressure present. This may explain the higher concentrations of DIC and TDN, and consequently, the highest mean values of electrical conductivity in these rivers.

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INVASION SUCCESS OF A NON-INDIGENOUS AQUATIC GASTROPOD: CHEMICAL CUE INTERACTIONS AND IMPLICATIONS FOR THE ECOLOGY OF THE ST LUCIA ESTUARY, SOUTH AFRICA

Lake St Lucia, in northern KwaZulu-Natal on the east coast of South Africa, is the largest estuarine lake in Africa and is located within the iSimangaliso Wetland Park, a UNESCO World Heritage Site. The St Lucia Estuary is a system of dynamic variability which undergoes shifts between hypersaline and limnetic states on a seven to ten year cycle. For the past decade, during a hypersaline state, the drought was enhanced by the separation of the Mfolozi River and persisting mouth closure. During this period the functionality of the estuary was degraded and the system became characterised by highly adaptable species which were able to tolerate the hypersaline conditions. However, despite prevailing high salinities during this period, a freshwater aquatic caenogastropod species native to South East Asia, Tarebia granifera, was accidentally introduced to the system. Our work has shown that T. granifera has a moderate tolerance and survives in salinities of up to 30. Freshwater seepage areas from aquifers on the eastern shore of the South Lake act as refugia for species which become dominant in the system once there is a shift back to the limnetic state, as has occurred in the past year. Range expansion of the non-native T. granifera has already been observed into areas with previously intolerable salinities. The large-scale impact of T. granifera is still unknown but our experiments show that chemical cues released by this non-native species drive a biotic interaction with native gastropods, causing an avoidance response. The displacement of native gastropods has been demonstrated following the successful long-term establishment of T. granifera. The closed mouth state that has prevailed for the last 10 years is now the major cause of its spreading through much of the system, as seawater is prevented from entering the estuary and limnetic conditions persist.

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RECREATION PROPOSAL FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH

The Sacramento-San Joaquin Delta and Suisun Marsh "serves Californians concurrently as both the hub of the California water system and the most valuable estuary and wetland ecosystem on the west coast of North and South America" (California's Water Code Section 85002). But it is much more than a water valve and important estuary—the Delta and Suisun

Marsh have significant cultural and recreational values. Waterways, parks, wildlife refuges, marinas, historic communities and pleasant country roads seem to be hidden from, but are well within reach of, millions of Northern Californians and other visitors. Opportunities for recreation will change as the region's landscape responds to new water management and ecosystem restoration initiatives. Investing in tourism and recreational facilities and programs, especially to facilitate public access to proposed ecosystem restoration areas, will benefit the region's economy by improving the quality-of-life for residents, attracting more visitors to experience the Delta and Suisun Marsh's recreation assets and authentic character, and providing permanent jobs and an increased tax base. When open space management agencies and recreation providers join together to implement the Gateway>Base Camp>Adventure strategy, described in the report and accompanying poster, it will help more people discover and enjoy the region's recreation opportunities while increasing institutional flexibility and reducing costs. Working together will contribute to the area's economic vitality, supporting jobs, growing businesses and improving the quality of life that makes the region an attractive place to live, visit and do business. The report offers a compelling long term vision for state, county and city planners, business and community leaders, and environmental organizations.

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UPSTREAM AND DOWNSTREAM WATER QUALITY NEAR AN OYSTER AQUACULTURE FACILITY

Bivalve aquaculture improves water quality through filtration and benthic pelagic coupling. It also results in areas of increased levels of inorganic nutrients. This study investigated the change in water quality parameters upstream and downstream of an oyster aquaculture facility located near the mouth of the Choptank River in Maryland. Water samples were taken upstream, downstream, and in the middle of the aquaculture facility during Summer 2013. Samples were analyzed for ammonia, phosphate, chlorophyll-a, and dissolved oxygen. Preliminary results from Spring 2013 show a decrease in chlorophyll-a and dissolved oxygen, and an increase in ammonia and phosphate as water passes through the facility. Results will be discussed in terms of nutrient cycling by bivalve aquaculture and the potential for integrating bivalve aquaculture with algal aquaculture methods.

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SYNERGIES BETWEEN LOUISIANA'S COASTAL MASTER PLAN AND NUTRIENT MANAGEMENT EFFORTS THROUGHOUT THE CONTINENTAL MISSISSIPPI-ATCHAFALAYA RIVER BASIN

Elevated nitrogen and phosphorus levels have been of concern throughout the Mississippi-Atchafalaya River Basin (MARB) for decades and efforts are currently underway by 12 states which are members of the Mississippi River Gulf of Mexico Watershed Nutrient Task Force (Hypoxia Task Force) to develop strategies to improve management of nutrients within their state waters. Louisiana is developing a Nutrient Management Strategy which integrates non-point source and point source nutrient management with nutrient assimilation through river diversions as prescribed in Louisiana's 2012 Coastal Master Plan. Wetlands have been used to intercept nutrients from municipal wastewater for over 60 years in Louisiana. In addition, wetlands have received diverted Mississippi River water for more than 50 years for habitat restoration and more recently (for the past 20 years) through the coastal restoration program as a means of restoring deltaic processes that have been interrupted by river management practices over the past 150 years. The synergies achieved by utilizing river diversions to restore the coastal processes, while at the same time improving nutrient management and reducing nutrient delivery to the Gulf is unprecedented. In addition to reducing nutrient inputs from Louisiana sources, Louisiana is uniquely positioned within the watershed to remove nutrients that are added by upriver states before they enter the Gulf of Mexico and contribute to Gulf Hypoxia.

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CHESAPEAKE BAY SENTINEL SITE COOPERATIVE: SUPPORTING RESILIENCE TO SEA LEVEL CHANGE AND COASTAL INUNDATION

Current rates of local sea level rise within the Chesapeake Bay region (range: 2.9-5.8 mm/yr) rank among the highest rates measured across the country and recent evidence indicates significant acceleration in SLR rates over the past four decades. As a result, coastal communities and natural resource managers need to better understand the potential impacts so that they can make responsible management decisions. The Chesapeake Bay Sentinel Site Cooperative (CBSSC), a group of regional representatives from federal, state, university, and non-profit research, management, and outreach institutions, is leveraging existing sea level change data observation infrastructure and targeting new investments where they will have maximum impact to support local and regional decision-makers. Initial efforts are focusing on sea level change impacts to vegetated coastal habitats. The CBSSC has designated five sites as fully functional sentinel sites with co-located water level instrumentation, accurate height information, surface elevation tables (SETs) and other bio monitoring infrastructure. These locations reflect the diversity of the Chesapeake Bay region as they include a variety of marsh types representative of coastal riverine and barrier island systems stretching across Maryland and Virginia. Beyond the creation of a forum to integrate existing assets and coordinate future expansion, current successes include the presence of consistent infrastructure across the initially selected sites, and the ability to compare wetland-water level relationships across the Cooperative. In addition, a regional Surface Elevation Table synthesis will help identify geographic trends as well as data gaps. Challenges include the need to incorporate sentinel data into local downscaled sea level rise impact models and the need to develop consistent applications of sentinel data to support natural habitat and community decision makers.

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CAN RESTORED MARSHES SURVIVE FUTURE SEA-LEVEL RISE IN THE SACRAMENTO-SAN JOAQUIN DELTA?

Tidal marsh restoration is a key element of most plans for restoration of the California Bay-delta ecosystem. Plans call for increasing the area of tidal marsh and the question of how and where tidal marsh restoration is feasible must be addressed. An additional, and perhaps more important question, is whether marshes restored at the start of the 21st century can survive sea-level rise towards the end of the 21st century. Sites with relatively little subsidence and a supply of riverine sediment are often viewed as more suitable for restoration and the new tule marshes on Liberty Island following levee breach provides an opportunity to explore the dynamics of the new wetlands and evaluate their possible future . As part of the BREACH III study, measurements of surface elevation change, and contributions of organic and mineral material to vertical soil development at Liberty inform thinking about the future of these marshes which are less than 20 years old. Data collection includes the transition from mudflat to marsh, and the role of physical drivers in elevation change. During the study period the mean rate of elevation change exceeded 1 cm/yr at several sites and soil development was dominated by the mineral fraction both gravimetrically and volumetrically. This study supports the finding of previous work on natural and restored marshes in the Delta, that despite the traditional view of delta wetlands as being peat dominated systems, mineral sediment is an essential component of soil development and vertical building. How these newly restored marshes survive for decades to come relies on sediment to build substrate but also the continued dominance of tules - with their high tolerance for submergence - to assist in trapping and retention of available sediments.

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SPATIAL AND SEASONAL TRENDS IN PHYTOPLANKTON COMMUNITY COMPOSITION IN RESPONSE TO NITROGEN IN FOUR SOUTH CAROLINA SYSTEMS

Human population density, and related urbanization, is predicted to continue to increase along South Carolina's (SC) coast over upcoming decades, and this may affect estuarine nitrogen (N) and phosphorus (P) levels. Regulators are therefore considering numeric criteria for estuarine N and P. In order to make informed decisions regarding nutrient water quality, biological responses to various N and P forms should be considered. This study examines spatial and seasonal variability in phytoplankton biomass and community composition in response to N form among four coastal SC habitats: a forested tidal creek, an urbanized tributary, a salt marsh estuary, and a stormwater detention pond. Seasonal field sampling and nutrient addition bioassays were conducted over two years (2011-13). Nine nutrient treatments: 1) no addition, 2) nitrate, 3) ammonium, 4) urea, 5) orthophosphate, 6) nitrate + phosphate, 7) ammonium + phosphate, 8) urea + phosphate 9) all (nitrate + ammonium + urea + phosphate) were produced to assess phytoplankton responses to N and P. Fluorometric analyses of chlorophyll *a* (chl *a*) were used to calculate phytoplankton biomass and high performance liquid chromatography was used to quantify photopigments. CHEMTAX was used to determine the relative contribution of algal taxa to total chl *a*. Preliminary results suggest that N-form, particularly organic N, likely influenced phytoplankton growth. Further, land use patterns may affect nutrient (especially N) source and therefore phytoplankton dynamics in these systems. In addition, southeastern blackwater streams, such as systems here, often have naturally elevated dissolved organic carbon (DOC) from terrigenous matter and, to a lesser extent, phytoplankton. Since DOC fuels microbial respiration and can contribute to seasonal hypoxia, levels of bacteria and DOC were assessed. Results suggest the need for site-specific nutrient criteria which could have substantial influence on estuarine water quality management.

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MICROBIAL ECOLOGY OF THE BENTHIC-PELAGIC INTERFACE WITHIN THE NORTHERN GULF OF MEXICO HYPOXIC ZONE

Coastal hypoxia affects the health and productivity of biologically sensitive and economically valuable near shore estuaries. The Gulf of Mexico hypoxic zone is seasonal, characterized by low oxygen concentrations in the mid water pycnocline and bottom waters. It displays spatial and temporal variability on seasonal, diurnal, and hourly timescales. The highly dynamic geochemistry can be a result of physical and chemical factors as well as microbial populations. In this study, we describe the metabolically active microbial communities associated with hypoxic water conditions in the water column and nepheloid layer. Temporal and spatial variations of metabolically active microbial populations were investigated along a well-studied 20 m isobath extending east of Terrebonne Bay to a location offshore from the Atchafalaya Bay. Water was collected using a unique coring devise that captured the nepheloid layer without mixing the water column or the disturbing the sediment. An RNA-based molecular characterization of the microbial population was used to determine the distribution of the metabolically active lineages. Bacterial SSU rRNA were sequenced (Roche 454 FLX) providing over 700,000 sequences with an average read length of more than 400 bases. Known photosynthetic lineages varied in frequency of detection at depth and time of sampling, as was expected. Additional lineages with the capacity for suboxic metabolic processes were detected mid-water column associated with hypoxic water formation. These data suggest hypoxic conditions persist long enough in the mid-water to promote a physiological response within the microbial populations. Results indicated microbial activity in the nepheloid layer represents a specialized zone of biological processes that should be considered in models describing mechanisms controlling hypoxia. In addition, temporal switches between photosynthesis and respiration should be considered when analyzing the extent of hypoxia.

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ASSESSING MOVEMENTS AND THE QUALITY OF DRYDOWN HABITAT FOR EVERGLADES RECREATIONAL FISHERIES: COASTAL NATURAL VS. WETLAND ARTIFICIAL?

Understanding both the behavioral drivers and the spatial implications of animal movement is a longstanding core theme in community ecology. In tropical pulsing systems such as the Florida Everglades, seasonal hydrology creates a temporally-variable habitat mosaic that influences patterns of animal abundance and distribution across both coastal and freshwater habitats. In response to this seasonal variation in habitat availability, fish move into deeper habitats, but little is known about their relative quality. We compared the quality of coastal mangrove creeks and inland manmade canals as drydown habitats for key mesoconsumers, known to use both habitats during the dry season (largemouth bass and bowfin). In creeks, we also compared the performance of these mesoconsumers to that of estuarine common snook. We assessed variation in patterns of abundance, size distribution and body condition, as well as their movements and distribution within each habitat. Boat electrofishing and PIT tagging mark-recapture techniques were used to sample fishes in both habitats over three years. Numbers of bass and bowfin were higher in canals, but condition was higher in creeks. Size distribution and movement rates also varied, with a greater contribution of juveniles and smaller individuals in canals. In creeks and at the peak of the dry season, freshwater mesoconsumers were two to five times more abundant than snook. Results suggests tradeoffs in habitat quality that likely influence the movement decisions of fishes, and highlight the importance of refuge habitats to population dynamics in pulsing systems, a role that may be increasingly important in the face of anthropogenic hydrological disturbance. Our findings also emphasize the importance of animal movement and spatial processes in driving ecological patterns across varied landscapes. We discuss results in the context of climate change (i.e., sea level rise in coastal creeks), and implications for recreational fisheries.

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BACTERIA, BIOFILMS, AND BAIT FISH: AN INVESTIGATION OF MARINE BIOFILMS FOUND ON TWO SPECIES OF FORAGE FISH ALONG THE SOUTHEASTERN US

Most marine biofilm research has been limited to fish farming and waste effluent into estuarine and coastal zones. Only recently has literature suggested that biofilms growing on substrates may act as cues to settling marine organisms. However, very little current research exists regarding the biofilms growing on larger marine organisms such as fish. As coastal zone development increases in addition to an increase in temperature of coastal waters due to climate change, the potential for pathogenic and antibiotic resistant gram-negative bacteria persisting in the marine environment increases. The current investigation seeks to determine the presence of gram-negative bacteria living on two species of forage fish commonly found in southeastern US coastal waters: Atlantic silversides (Menidia menidia) and bay anchovies (Anchoa mitchilli). Both species are important in the transfer of energy within coastal zone food webs serving as food for economically important species such as bluefish, striped bass, and Atlantic mackerel. Fish were caught using a quarter-haul seining technique at three sites: Hunting Island State Park (SC), Fort Pulaski National Monument (GA) and Tybee Island (GA). Fish, sand, and water were swabbed and bacteria were plated while in field on MacConkey agar. Samples were transferred back to the lab, and placed in an incubator for 24 hours. Bacteria were purified and characterized biochemically, as well as tested for antibiotic resistance.

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A BI-NATIONAL APPROACH TO CONTROLLING EL LADRON DE AGUA TO ENSURE RIO GRANDE WATER CAN REACH THE ESTUARY

"Arundo donax" or Carrizo cane is termed el Ladron de Agua - the water thief by Mexicans, and represents significant source of water loss in southwestern tributaries. Stands of cane can be hundreds of feet deep with more than 10 stems per square foot, and a transpiration rate in excess of 500 gal per m per day. The cane can be controlled by mechanical, chemical or biological means to reduce its vigor; allow revegetation by native plants which are more economical in their water usage; and allow enough water to remain in the Rio Grande to reach the estuary at Brownsville, an estuary which has frequently had no freshwater input. This presentation reports on a number of comparative studies of control methods. It indicates that "traditional methods of control" such as mechanical removal, controlled burning, mowing or herbicide application can be inordinately expensive and subject to less than acceptable levels of control. In addition these methods damage riparian habitat, and require costly revegetation. Biological control methods or hybrid methods employing both mechanical control and biological control may be economical enough for widespread use on this invasive species, and are less damaging to habitat. Given the estimated acreage of

Carrizo cane in the Rio Grande and the cost per acre for removal identified by this study, the use of biological control methods or hybrid methods may be a practicable and affordable alternative to controlling el Ladron de Agua.

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HABITAT DIFFERENTIATION OF SYMPATRIC NATIVE AND INVASIVE GAMMARIDS (CRUSTACEA, AMPHIPODA)

Habitat differentiation can facilitate the coexistence of taxonomically and morphologically similar species in a given region. Six sympatric species of the amphipod genus Gammarus can be found in the brackish water northern Baltic Sea. There are five native Gammarus species: G. zaddachi, G. salinus, G. oceanicus, G. duebeni and G. locusta, and an invasive species G. tigrinus that originates from North America. G. tigrinus was found for the first time in the northern Baltic Sea in 2003 and its range has been continuously expanding. In this study we hypothesized that there is a habitat differentiation between native and invasive gammarid species. We specifically addressed the question whether the habitat characteristics of the invasive G. tigrinus differ from that of the native species. Habitat characteristics like water temperature, salinity, depth, wave exposure, water transparency and chlorophyll concentration, seabed substrate, and macrophyte biomass of the six gammarid species were compared in the northern Baltic Sea. Habitat differentiation between the gammarid species was confirmed. Clear separation of habitat preferences was found between native species and the invasive species in terms of both abiotic environmental conditions and macrophytes. G. tigrinus inhabited shallow sheltered areas characterized by low salinity, high water temperature and macrophyte communities dominated by charophytes. Compared to G. tigrinus, native gammarids preferred deeper and more wave exposed areas with higher water salinity and macrophyte communities dominated by phaeophytes and rhodophytes.

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OBSERVING ESTUARIES SEDIMENT DYNAMICS FROM SPACE: USAGE OF SATELLITE REMOTE SENSING TO UNDERSTAND THE VARIABILITY OF SUSPENDED SEDIMENT ALONG THE TEXAS CLIMATE GRADIENT

Understanding the variability of suspended sediments in estuaries is important from a process-based perspective and for regulatory and managerial purposes. Process-based understanding of estuarine sediment dynamics can also provide insight into morphodynamics and evolution of estuaries and their environments, such as salt marshes and seagrass beds. In recent years, the use of satellites provides synoptic views and insight into processes controlling the variability of their suspended sediment concentrations both spatially and temporally. As these satellite data records reach decades of daily observations, analyses of these data also provides climatological understanding of estuarine sediment dynamics. Here we present the preliminary results of a suspended sediment reflectance algorithm for quantifying suspended sediment concentrations from images collected by the NASA polar-orbiting satellites caring the MODIS sensor and a comparative time series analysis using satellite derived sediment data of the three major estuaries on the Texas coast. Major estuaries in Texas (Galveston, Matagorda, and Corpus Christi Bays) are shallow, wind-dominated systems, prone to wave resuspension of sediment. These estuaries exist along a climate gradient, and their average annual freshwater inflow decreases 10 fold from north to south, normalized by bay volume, while marine sediment input is minimal due to their microtidal setting. To understand sediment dynamics of these estuarine systems the comparative analysis was conducted using wind data, wave models, inflow data, and suspended sediment concentration derived from satellite data. This analysis shows that inflow and wave resuspension are the primary drivers of estuarine sediment dynamics on the Texas coast. The source of the suspended sediment, however, differs among estuaries. Sediment concentrations in Galveston Bay are influenced by inflow, while concentrations to the south are influenced more by wind-wave energy.

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SETTLEMENT PATTERNS OF SPOTTED SAND BASS, *PARALABRAX MACULATOFASCIATUS* IN MISSION BAY, SAN DIEGO, CA

Estuaries are widely recognized as important nurseries for a variety of fishes and invertebrates. Despite this, in Southern California, relatively little is known about patterns of larval supply (settlement) to estuarine environments. Measurement of larval supply is critical as high variability in the number of larvae that survive to reach juvenile habitat is an important determinant of future population strength. In this study, we used standard monitoring units for the recruitment of fish (SMURFs) to examine weekly settlement patterns of spotted sand bass, *Paralabrax maculatofasciatus* from June-October of 2012 and 2013 in Mission Bay, San Diego, CA. Spotted sand bass are commonly found in shallow bays and harbors of southern California and are targeted by recreational anglers. Our objectives were to examine annual and inter-annual variation in settlement patterns of Spotted sand bass by comparing rates of larval delivery to time of the year, lunar phase, as well as local ocean conditions including: sea surface temperature, upwelling, salinity, Chlorophyll-A, and alongshore transport. Knowledge of factors that impact temporal variation in settlement is essential for effective management and conservation.

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DO PESTICIDES CAUSE RISKY FISH BEHAVIOR? SUITES OF BEHAVIORAL CHANGES OF A COMMON ESTUARINE FISH, *FUNDULUS PARVIPINNIS* AFTER PESTICIDE EXPOSURE

Pesticides are prevalent contaminants of urban estuarine and coastal systems, yet their ecological consequences for resident organisms are relatively understudied. The effects of sublethal pesticide exposure on individual behaviors are particularly poorly understood. However, diverse behaviors may influence individual survival as well as population ecology. Here, a common estuarine species, the California killifish (*Fundulus parvipinnis*) served as a model to study behavioral changes and their ecological consequences following sublethal exposure to chlorpyrifos (a common organophosphate pesticide). To quantify suites of individual fish behaviors in different ecological contexts, a novel video data approach was used. Juvenile fish were exposed to two chlorpyrifos concentrations for four days prior to behavioral observations in an experimental arena to assess their activity and exploration in a novel environment. Additional behaviors studied included social behavior and the willingness to forage in the presence of a model avian predator after a simulated predator attack. Our results indicate that pesticide exposure altered multiple ecological behaviors, including activity levels, surfacing behavior, sociality, and an anti-predator response. These behavioral changes carry potential ecological consequences including heightened predation risk. This study confirms that behavioral responses are sensitive and ecologically relevant endpoints to contaminant exposure.

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MODELING SEA LEVEL RISE IMPACTS TO THE VARIED GEOMORPHOLOGY OF THE CALIFORNIA COAST

The California coast represents a diverse array of geomorphologies. Following the last interglacial, the coastline has transgressed forming the current geomorphic alignment. These geomorphologies continue to evolve based on the coastal backshore type largely controlled by geology and wave exposure. This presentation focuses on two case studies of spatial modeling efforts in California using relationships between geomorphology and coastal processes. Model development, strengths and weaknesses, and inherent uncertainties will be presented. Model results map hazard zones similar to a FEMA coastal study but also incorporate erosion and sea level rise. These models have been developed and results reviewed during stakeholder processes to refine outputs and support the incorporation of model results into planning processes. The basis for the modeling is the unique backshore classification which forms the scale of analysis. This classification identifies the backshore type, divides the backshore type based on the geology, and then subdivides the geologic/backshore type into 500m alongshore blocks. To represent local conditions, blocks are attributed with geomorphic data to provide model inputs. These inputs include beach slope to calculate wave run-up, toe elevation to evaluate exposure of the backshore to erosion, crest elevation to assess exposure to coastal flooding, and historic trends in shoreline change which indirectly represent the sediment budget. In the first case study, impacts of sea level rise on coastal erosion, coastal flooding, and fluvial flooding was projected in Ventura, California. By integrating coastal erosion and flooding in 10 year time steps additional flood hazards are identified through hydraulic connectivity. Change to fluvial flooding was modeled using precipitation outputs from downscaled GCMs and coastal flooding results. The second case study projected impacts to the various cliffs, inlets, and dunes around Monterey Bay, California.

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LONG-TERM CHANGES IN WATER QUALITY VARIABLES RELATED TO EUTROPHICATION WITHIN SOME BASQUE ESTUARIES (NORTH OF SPAIN)

Since 1995, chlorophyll "a" (chl-a), oxygen and nutrients are measured in the Basque coast. In this study we present a trend analysis for three bays (the outer reaches of the Nervion, Oiartzun and Bidasoa estuaries) that share similarities in morphological and hydrodynamical features. The estuaries from the North of Spain, in general, flush quickly and have a low susceptibility to eutrophication. However, the studied systems are relatively deep and the water residence time is usually high enough to allow the development of phytoplankton blooms. Salinity at the studied systems is quite similar; in average, it indicates euhaline or polyhaline conditions. In contrast, the main drivers of eutrophication pressure (population and industrial density) differ among them, affecting more importantly the Nervion and the Oiartzun estuaries. In addition, the wastewater management has been subject to several modifications during the last decades. The outer Nervion estuary shows a sustained decreasing trend in the chl-a and in the ammonium concentration. This trend seems to respond to the implementation of the biological wastewater treatment. Indeed, an index based on chl-a shifts from significantly disturbed conditions to undisturbed conditions. An opposite trend for chl-a is found in the Oiartzun bay. In this system, organic matter and suspended solids have been reduced, but it still receives important loads of inorganic nutrients. The Bidasoa bay, a system that has been historically less influenced by anthropogenic pressure, also shows fluctuations in the chl-a, but the index varies only between no disturbance and slight disturbance conditions. Finally, the oxygen saturation conditions improve in the Nervion and the Oiartzun bays, and remain good in the Bidasoa bay. In conclusion, to assess eutrophication with confidence in estuaries, long-term monitoring is necessary. In addition, simple indices based on variables that are routinely monitored can be effective for this purpose.

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LIBERTY ISLAND LANDSCAPE FRESHWATER VEGETATION RESPONSE TO SEA LEVEL: A MODELING APPROACH

A landscape vegetation model was developed to provide a predictive level of understanding about abiotic and biotic controls on vegetation colonization and expansion on Liberty Island, CA with the goal of investigating how to restore wetlands integrating historical and concurrent environmental data, and assess the evolving wetland features at the landscape scale The initial conceptual model developed from the BREACH studies was used as base for an evolutionary path from subtidal open water, through emergent mudflats to vegetation colonization and ultimately mature marshes. This conceptual model identified different stages in wetland development and articulated the interactions among these factors for intertidal pioneer and mature tule (Schoenoplectus acutus) conditions. We implemented this conceptual model unto a large-scale dynamic model to understand how hydrologic and geomorphic changes and ecological responses at different scales from local to the entire restoration site, and relationships to the adjoining landscape. The result was a multiple-scale biophysical model for the Liberty Island marshes capable of simulating long-term regional habitat change. This mechanistic process-based ecological landscape model assessed "restoration thresholds" of emerging wetlands. This type of spatial model incorporates location- specific algorithms to allow feedback between the local processes and landscape dynamics. Thus, the biophysical model for Liberty Island compiles physical and biological information at different scales in three modules: hydrodynamic, soil, and macrophyte productivity dynamically coupled via a unit ecosystem model. Calibration results show that plant colonization is highly correlated to water depth and wave exposure. Model results could be used to assess how restoration goals can be met using water transport and routing influence changes in habitat composition within the basin.

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BIODIVERSITY, ENVIRONMENT, AND EELGRASS ECOSYSTEM FUNCTIONING ON A PLANETARY SCALE

Ecosystem processes are mediated by interactions between resource supply, consumer pressure, and community composition, with the balance shifting along environmental gradients. A frontier in basic and applied ecology is understanding how these multifarious processes interact, and organizing the complexity into predictive models. One promising way forward is the comparative-experimental approach, integrating standardized experiments with observational data. In the Zostera Experimental Network (ZEN, www.zenscience.org) collaborators across 15 partner sites study the ecology of communities associated with eelgrass (Zostera marina), the most widespread marine plant and foundation of important but threatened coastal ecosystems throughout the northern hemisphere. In 2011, parallel field experiments factorially added nutrients and excluded crustacean mesograzers for four weeks, and measured community and ecosystem responses. Structural equation modeling revealed unprecedented strong correlations of biodiversity, both eelgrass genotypic diversity and grazer species richness, with plant and grazer biomass and production even across global gradients in environmental factors. These results largely corroborate controlled, small-scale biodiversity experiments and suggest that impacts of biodiversity loss on ecosystems will be of comparable magnitude to those of other global change factors.

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ESTUARINE RESIDENCE TIMES ESTIMATES BASED ON RELEASED DROGUES WITHIN A HYDRODYNAMIC MODEL

The New River Estuary (NRE), NC, a discharge, wind, and tidally driven estuary, is the focus of a hydrodynamic modeling study that seeks to understand the residence times of the estuary for a range of discharge conditions. The estuary is shallow (maximum depth of approximately 4m with deeper holes around structures); tidal and wind mixing is sufficiently strong that the estuary is typically well mixed over the vertical. Flow characteristics within the estuary, including depth averaged velocities and water levels, were computed using the ADCIRC hydrodynamic model with tidal and discharge forcing. Output from the model was validated by comparison with ADCP data collected at different locations and times in the estuary. The validated model was then used to simulate flow conditions with and without tides using one of 6 freshwater discharge rates centered about the average annual discharge into the estuary. The model domain was divided into 6 sections and each section was seeded with 300 drogues. For each simulation, the movement of the drogues within and out the estuary was recorded and the time of travel noted. For each section, an average transit time, or residence time, through the section was computed as well as transit time out of the estuary. Not unexpectedly, residence times increased in proximity to the head of the estuary. Inclusion of the tides, increased residence times in the upper portion of the estuary, but decreased residence times near the mouth of the estuary. Visual exploration of model and drogue results identified possible retention areas and strong expo

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THE EFFECTS OF ENVIRONMENTAL CONDITIONS ON GROWTH RATES OF THE INVASIVE ASCIDIAN *BOTRYLLOIDES VIOLACEUS* IN A SOUTHERN CALIFORNIA BAY

Fouling communities within southern California harbors are often dominated by ascidians, many of which are non-indigenous species that persist and out-compete native species. In Mission Bay, a relatively shallow mesotidal estuary in San Diego, the non-indigenous species *Botrylloides violaceus* settles along man-made structures such as marina docks and can be locally abundant. We hypothesized that spatial differences in environmental conditions would impact *B. violaceus* growth rates. PVC plates (13 x13 cm) were deployed at four Mission Bay locations for one year (Fall 2011- Fall 2012) and photographed weekly to identify the spatial and temporal settlement patterns of ascidian species. Temperature, salinity, water clarity, and flow were measured at the time photographs were taken. ImageJ was used to calculate % area cover and growth rates of *B. violaceus*. Although *B. violaceus* growth was spatially variable, temperature and salinity measures were within the reported tolerances for this species. In general, growth rates were greatest when temperature and salinity were relatively low. An understanding of how *B. violaceus* responds to changing environmental conditions will allow us to better predict the potential biotic impacts this species might have outside of its native range.

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RARITY AS AN INDICATOR OF ECOSYSTEM HEALTH

Biological diversity, on average, increases community stability by harboring a variety of organisms that can respond to environmental fluctuations and maintain ecosystem function after a perturbation. However, when using traditional multivariate analyses to assess ecological integrity, occurrences of rare species are often transformed and removed. Even though biodiversity is a standard measure for assessing ecosystem integrity, the debate is not settled on whether rare species can be removed from data sets without having an impact on ecological assessment. It is possible that the property of rarity itself (proportion of rare species over various temporal and spatial scales) could improve ecological assessments of biodiversity. The signal of rare species occurrence may also contain additional information on the resilience and recovery rate of ecosystems. This presentation will compare common

measures of ecological integrity utilizing various long-term data sets of macrobenthos in Texas Bays and Estuaries to investigate how rare organisms complement patterns of ecosystem stability. For example, are rare organisms observed more frequently in certain seasons? Does the proportion of rare organisms at a given site or time correlate with other measures of ecosystem health? Does the inclusion/exclusion of rare species in multivariate analyses impact the relative assessment of ecosystem health between sites and times?

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LANDSCAPE AND SEASONAL HETEROGENEITY IN THE COMPOSITION OF LOWER TO MIDDLE TROPHIC LEVELS IN PUGET SOUND'S PELAGIC FOOD WEB

We sampled lower to middle trophic levels in surface waters across five oceanographic subbasins of greater Puget Sound in nearly 600 daytime monthly surface trawls from 80 sites during March–October 2011. Counts and biomass of of zooplankton and small fishes differed across seasons, but even more so across the various subbasins. Fish dominated in the northern basins of Puget Sound, whereas jellyfish dominated in the southern basins. Multivariate structure in microbial, zooplankton, fish, and jellyfish assemblages correlated, indicating strong spatial heterogeneity in the pelagic food web structure across greater Puget Sound. These observations have important implications for ecosystem assessment and monitoring, at a minimum demonstrating that current status and target conditions for the living system are not uniform across Puget Sound. We explore the likely natural and anthropogenic causes of the observed patterns, and make recommendations for future research and monitoring.

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SPATIAL AND TEMPORAL TRENDS IN RUNOFF AT LONG-TERM STREAM GAUGES AND IMPLICATIONS FOR CLIMATE CHANGE EFFECTS IN CHESAPEAKE BAY WATERSHED

Long-term streamflow data were analyzed to identify trends in runoff within the Chesapeake Bay watershed and surrounding area. Data from 28 streamgages were analyzed for the period 1930-2010. Streamflow data were converted to runoff and trend slopes in percent change per decade were calculated. Trend slopes for three annual runoff statistics were analyzed: 7-day minimum; mean; and 1-day maximum. The slopes also were analyzed both spatially and temporally. The spatial results indicated that trend slopes in the northern half of the watershed were generally greater than those in the southern half. The temporal analysis was done by splitting the 80-year flow record into two subsets: 1930-1969 and 1970-2010. Results indicated that the period 1930-1969 was statistically significantly different from the period 1970-2010. For 7-day minimum and mean, the latter period had significantly higher runoff than did the earlier period, although within the two periods no significant linear trends were identified. For 1-day maximum runoff, no step trend or linear trend could be shown to be statistically significant for the north, while the south showed a mixture of an upwards step trend accompanied by linear down-trends within the periods. In no case was a change identified that indicated an increasing rate of change over time. Given the general increase in low flows and the lack of a general increase in high flows, there is no indication of an increase in the variability of streamflow over the 80-year period. Continuing empirical analysis of streamflow and precipitation patterns is an important component of the research needed to understand and predict changing hydrologic conditions that may be happening due to changes in the greenhouse forcing and climatic conditions for the Chesapeake Bay region.

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DETERMINING THE TROPHIC STRUCTURE AND UNDERLYING NUTRIENT SOURCE DYNAMICS OF AN ESTUARINE PREDATOR, CYNOSCION NEBULOSUS, IN A RIVER DOMINATED ESTUARY

Apalachicola Bay, located in the panhandle of northwest Florida, is one of the most productive estuaries in the northern hemisphere. The Bay has an extensive network of seagrass beds, brackish water sub-aquatic vegetation, oyster reefs, and saltmarshes which are thought to provide food resources and predation refuge for several ecologically and economically important marine species. While prior studies have investigated the spatial and trophic dynamics of estuarine fish communities in Apalachicola Bay and other estuaries, few have included piscivores that occupy the highest trophic levels in the system. By combining δ13C, δ15N and δ34S stable isotope analysis and gut content analysis we aim to: (1) determine the relative importance of different sources of organic carbon (seagrass, saltmarsh vegetation, terrestrial detritus, phytoplankton) underlying the productivity of seatrout in Apalachicola Bay, and (2) investigate how diet and trophic level of seatrout varies spatially in relation to habitat type and seasonally in relation to variation in river flow. Preliminary δ13C and δ34S isotopic data suggest that seatrout inhabiting the freshwater dominated regions of the bay are supported via a plankton based food web while seatrout occupying the more saline lower regions of the bay rely more heavily on benthically derived carbon sources such as seagrass and macroalgae. While the relative importance of differing carbon sources varied spatially, these observed patterns appeared unaffected by seasonal changes in river flow, potentially due to unusually low flow rates during the study. Throughout all regions of the bay, δ15N isotope and diet data suggest seatrout undergo an ontogenetic shift in diet of mostly decapod crustaceans as juveniles to a diet of mostly finfish as adults. This study marks the first attempt to delineate the sources of primary productivity supporting an apex predator within Apalachicola Bay across spatial, temporal and ontogenetic time scales.

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KEEPING OUR HEADS ABOVE WATER: SEA LEVEL RISE ADAPTATION AT THE CORTE MADERA WETLANDS

This interdisciplinary project is one of the first efforts in San Francisco Bay to investigate how wave attenuation across mudflats and marshes is sensitive to sea level rise, and to examine how management measures could improve wetlands resilience to sea level rise and thereby maintain flood risk reduction benefits. Currently, wave heights are reduced by as much as 80 percent as waves travel across Corte Madera Bay and are further reduced as they travel over the Corte Madera marshes. Field measurements and 1-D and 2-D modeling demonstrated that wave attenuation is more sensitive to water level than wave height or vegetation species. Since wave attenuation is largely determined by water depth, flood risk reduction benefits depend on wetlands being able to keep up with sea level rise. Regional marsh accretion models predict that the Corte Madera marshes will drown and convert to mudflats towards the end of the century, and several lines of geomorphic evidence indicate that the Corte Madera wetlands are sediment-limited. Proactive management measures will therefore be needed to preserve high, wide mudflats and marshes and associated ecosystem services such as flood risk reduction in the face of sea level rise. Seven management measures were considered, and using a geomorphic conceptual model as a decision-support tool, four were selected that could decrease mudflat and marsh edge erosion, increase marsh accretion, and provide space for gradual upland transgression. This project provides proof of concept that mudflats and marshes provide a natural, first line of defense against coastal flooding and demonstrates the kind of information and process that can be used to develop ecosystem-based solutions to protect communities.

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LOST RIVER PRESERVE HABITAT RESTORATION ASSESSMENT: VEGETATIVE AND NEKTON SAMPLING

A 70-acre site (Lost River Preserve) along the eastern shoreline of Tampa Bay, FL, was re-contoured into estuarine habitat with a hydrologic connection to Tampa Bay. In order to evaluate the effectiveness of restoration efforts, the estuarine and oligohaline restoration sites were surveyed for nekton and emergent plants by: 1) sampling within quadrats at haphazard positions along permanent transects, 2) sampling along belt transects, and/or 3) sampling within permanent plots. Abundance of vegetation was examined using two metrics: 1) groundcover of each plant and 2) frequency of plant occurrence within quadrats. Nekton sampling included taxa identified and enumerated live from seine collections. New plant species recruited into the LRP estuarine site, all plant assemblages displayed an increase in plant abundance (cover) and increase in mangrove density. Fifty-one taxa were collected from nekton samples at the LRP restoration site. The top 15 species by total percent catch constituted over 95% of all nekton collected. Nekton collected ranged from 82 to 3014 individuals, with the largest abundance recorded on the final sampling date. The total number of species recorded ranged from14 -22, with the initial and final sampling dates having a total of 22 and 21 species, respectively. The increase in plant abundance/cover at the estuarine and oligohaline restoration sites through April 2012 provides strong support for successful introduction, establishment and growth of vegetation that is characteristic of natural habitats rimming the Tampa Bay coast. Moreover, vegetation planted at the LRP estuarine site not only persisted over time, but new species recruited into the site. Together these findings for nekton and emergent plants at LRP provide strong evidence for a successful restoration effort based upon assessment of the early stages of plant community development and nekton community composition.

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RANGE EXPANSIONS AND REPRODUCTIVE STRATEGY: A MANGROVE CRAB IN THE SALT MARSH

The geographic ranges of most plants and animals are limited by climatic factors, and changes in global climate trends have caused species from a wide array of taxa to shift or expand their distributions into higher elevations and latitudes. Because organisms differ in the type and timing of their responses to climate changes, the range expansions of many animal species outpace that of their habitat. This leads to novel ecosystems with unique compositions and plant-animal interactions. One example of this phenomenon can be seen in the mangrove tree crab *Aratus pisonii*, a major consumer in neotropical mangrove systems. The northward movement of *A. pisonii* has recently outpaced that of its native mangrove habitat, resulting in populations establishing in salt marsh vegetation. Organisms such as *A. pisonii* that expand their range into foreign environments often alter their behavior, resource use, and life history characteristics in an attempt to maximize their reproductive success under the challenges presented by these new habitats. In order to explore potential alterations in the life history characteristics of *A. pisonii* as it expands its range northward, we compared populations from mangrove habitats within the species' historical range and from salt marshes near the northernmost boundary of its current distribution. We examined body size distributions, size at maturity, and reproductive effort of populations from both areas. Additionally, we investigated differences in the maternal reproductive investment of individuals from both populations by comparing egg size and weight, brood size, and starvation resistance of recently hatched zoeae. This study details the reproductive strategy of a major mangrove consumer as it colonizes novel salt marsh habitats, and provides insight into the potential mechanisms enabling this species and countless others to successfully expand their range into novel environments.

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BUILDING AN ONLINE COMMUNITY THAT FOSTERS KNOWLEDGE OF CALIFORNIA'S OCEAN HEALTH: THE LAUNCHING OF OCEANSPACES

Fishermen, scientists, policymakers and other stakeholders are deeply interested in scientific monitoring that is yielding new knowledge about California's marine protected areas (MPAs) and ocean health. When the MPA Monitoring Enterprise was charged with managing the state's MPA monitoring programs, we considered new ways to engage a diverse audience and enable individuals to create and share new knowledge. Are there new technologies that could lend greater transparency, salience and context to the data? How can consumers and producers of the data be brought closer together for their mutual benefit? How can technology help connect stakeholders with science and lend greater support to science at the management table? Out of these needs, OceanSpaces was born. We will share our approach to building a new online community with proven open-source technology and a strong subject-matter focus. By marrying versatile technologies with a clear purpose, OceanSpaces is custom designed to meet the challenges of an evolving community nimbly and effectively. The site features open-source communication tools to promote outreach and combines them with a customized version of Open Atrium's collaboration suite to foster complex, sustained teamwork. As an outgrowth of a collaborative effort, an ebook hosted on OceanSpaces demonstrates the possibilities. This ebook report for the Central Coast Symposium engaged stakeholders as it provided scientific results in an interactive format. Such outreach efforts and new ways of imagining stakeholder engagement are reflective of a new model for fostering science in the public sphere.

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LONGITUDINAL SALINITY STRUCTURE IN THE RUSSIAN RIVER ESTUARY THROUGH CLOSURE-BREACHING CYCLES: A STORY OF INTRUSION AND RETENTION

The Russian River, in northern California, flows to the ocean through a long and narrow estuary that alternates between being closed off from the ocean by a sandbar and being partially open with muted tidal exchange between estuary and ocean. Saline waters that intrude more than 10km into the estuary are trapped by shoals at the mouth and elsewhere in the estuary basin, resulting in intense stratification and increasingly muted tidal flows away from the mouth. When the mouth closes, the estuary resembles a salt-stratified lake with only weak wind-driven motions. Here we present selected data from five years (2009 to 2013) of surveys of the longitudinal distribution of salt during the low-inflow season (May through October), showing how this changes through cycles of mouth closure and breaching – and contrast the observed structure with that of a classical salt-wedge estuary. During mouth closure, rising estuary water level causes inundation of lateral banks and at times significant lateral hydrological structure can develop. The salt-dominated physical structure leads to dramatic layering of biogeochemical parameters. Specifically we point to longitudinal-vertical distributions of phytoplankton and POM as indexed by chlorophyll fluorescence and turbidity and briefly relate these to observations of dissolved oxygen in the estuary (see Hewett & Largier abstract).

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LOUISIANA BRACKISH AND SALT MARSH SOIL GREENHOUSE GAS FLUXES FOLLOWING THE DEEPWATER HORIZON OIL SPILL AND SALINITY MANIPULATIONS

We quantified the effects of the Deepwater Horizon oil spill and altering salinity on gaseous carbon fluxes from oiled and unoiled Louisiana marshes. We measured CO2, CH4, and N2O fluxes seasonally during 2 years (2012: monthly from May – September; 2013: bi-monthly from March – November) along transects of increasing distance from marsh edges at 4 sites (2 unoiled, 2 oiled) in Terrebonne Bay. In summer 2012 we quantified the effects of altered salinity (5, 15, 25, 35 ppt) on CO2 and CH4 production on laboratory-incubated soils from 8 marshes (4 unoiled, 4 oiled) in Terrebonne and Barataria Bays. In summer 2013 we compared CO2 and CH4 production on laboratory-incubated soils associated with Spartina alterniflora and Avicennia germinans from unoiled and oiled Barataria Bay marsh sites. In seasonal measurements from Terrebonne Bay marsh sites, we found significant monthly variability in net GHG fluxes (CO2 and N2O higher earlier in season); CO2 was the major driver of soil radiative balance; CO2 fluxes increased with distance from marsh edge and were positively correlated with soil C, N and water content; and CO2 and CH4 fluxes were higher at shallow water depths. In laboratory assays, CH4 production was higher in Terrebonne Bay and unoiled soils; CO2 and CH4 production decreased with increased soil C:N and increased with water content; CO2 production increased and CH4 production decreased with salinity; CO2 production increased as the magnitude of salinity manipulation was increased relative to field conditions; and the slope of the CO2 response to increased salinity was positively related to soil C, N and water content. Oil had no (seasonal field measurements) or limited (CH4 production in laboratory incubations) effect on carbon flux 2-3 years post-exposure. These results have important implications for wetland carbon models and how fluxes may respond to both episodic (e.g., oil spills) and persistent (e.g., sea level rise and salt water intrusion) stressors.

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HUMAN NUTRIENT SOURCE AND CLIMATE IMPACTS ON PUGET SOUND DISSOLVED OXYGEN THROUGH 2070

Parts of Puget Sound currently experience low levels of dissolved oxygen, and oxygen levels have been declining since the earliest widespread measurements began in the 1950s. The Washington State water quality standards stipulate that human sources cannot worsen dissolved oxygen where oxygen is naturally low. Recent advances in numerical modeling allow water quality managers to tease out the relative influences of human contributions from the Puget Sound watershed from the influence of the Pacific Ocean under current and future conditions, considering anthropogenic and climate stressors. Nutrient loads projected through the 2070s reflect a doubling of the population, with concomitant increases in wastewater effluent and changes to nutrient delivery from watersheds discharging to marine waters. Climate models suggest changes in air temperature and other meteorological parameters specified as boundary conditions for the circulation and dissolved oxygen model. Coupled climate and hydrology models indicate shifts in the hydrologic regime of major rivers that will influence nutrient delivery to Puget Sound. In addition, trends in nutrient concentrations and dissolved oxygen in the North Pacific are in the direction of worsening oxygen in Puget Sound. Very little information is available to characterize how future climate will influence ocean conditions at the open boundary. This effort is the first to evaluate the relative influence of three factors on future dissolved oxygen levels in Puget Sound: increased wastewater effluent with and without changes to wastewater treatment technology; shifts in hydrologic regimes and nutrient delivery by rivers; and trends in Pacific Ocean conditions that influence estuarine dissolved oxygen. Uncertainty surrounds each of the factors plus the dissolved oxygen response. However, the relative influences provide water quality managers with the first glimpse of how Puget Sound dissolved oxygen might look through the 2070s.

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THE IMPACTS OF URBAN, SUBURBAN, AND RURAL STORMWATER RUNOFF ON SELECTED METABOLIC PROCESSES WITHIN SOUTHEASTERN NORTH CAROLINA TIDAL CREEKS

Growing scientific evidence suggests that stormwater runoff is the most pressing and deleterious problem impacting coastal waterways. Stormwater runoff originates from impervious cover that prevents the natural infiltration of precipitation; these surfaces act as a source and a conduit for runoff to sweep over the landscape and pick up a vast array of contaminants that may then be delivered to adjacent receiving waters.The components of stormwater runoff can deleteriously impact a range of biological, chemical, and physical water quality parameters in the receiving water body. This project aims to better characterize the components of stormwater runoff from three different types of landscape catchments, while assessing the variable impacts of these stormwater inputs on tidal creek primary productivity and respiration. Receiving water was collected from two sites along Hewlett's Creek the day prior to an expected rain event. Stormwater was collected from an urban, suburban, and rural stormwater flow during significant rain events. Stormwater samples were analyzed for nutrient content and organic carbon. A suite of bioassays was undertaken using 10% and 30% stormwater amendments to each respective type of receiving water; a biochemical oxygen demand assay, a chlorophyll a and planktonic community incubation assay, and a light/dark bottle incubation assay were carried out to derive information about stormwater impacts on receiving water productivity and respiration. Preliminary results suggest that stormwater from each type of impervious cover categorization possesses a unique nutrient signature. Furthermore, each type of stormwater causes differential changes in the degree of respiration and the taxonomic makeup of the plankton community, with urban stormwater most seriously impacting observed parameters particularly in the light/dark bottle BOD incubations. However, considerably more experimentation must occur before further concrete conclusions can be posited.

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THE POTENTIAL OF GENOMIC TOOLS FOR ENVIRONMENTAL STATUS ASSESSMENT: THE DEVELOPMENT OF A GENETIC MARINE BIOTIC INDEX AS CASE STUDY

Genomic approaches based on high throughput sequencing technologies have revolutionized biological research. Applied to ecological studies, genomics has the potential to provide accurate, rapid and cost efficient environmental status assessment and biodiversity monitoring. In particular, metabarcoding, which consists on sequencing environmental DNA to assess the species present in a sample, can yield easier to perform and more reliable taxonomic identification than the traditionally performed visual analyses. In this presentation, we will review the technological advances in genomics technologies and their implications in improving the accuracy of environmental assessment, and in facilitating implementation of routine monitoring programs. Finally, we will use the progresses on the development of a genomic technology based AZTI's Marine Biotic Index (AMBI) as a case study. The AMBI provides a measure of ecological quality status based on the proportion of the five ecological groups into which the benthic species are classified. This classification requires a tedious and time consuming visual identification of the samples by expert taxonomists; metabarcoding has the potential to increase accuracy of benthic species identification, allowing calculation of the AMBI of a large quantity of sites in just a few days.

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INVESTIGATING THE IMPACT OF *PHRAGMITES AUSTRALIS* ON BLUE CRAB AND FISH POPULATION ABUNDANCE, SEX RATIO, MOLTING FREQUENCY, AGE CLASS, AND SIZE IN BLACKBIRD CREEK, DELAWARE

The blue crab (Callinectes sapidus) is a very distinctive and commercially important species for the Delaware Bay. While C. sapidus is generally perceived as a foraging bottom dweller, the blue crab also utilizes various muddy intertidal marsh habitats. Recruits, juveniles and adult blue crabs flourish in the dynamically structured mosaic of subtidal and intertidal marsh vegetation where the leaves, roots, and stems of plants serve as nutrition, protection from predation, and shelter during vulnerable stages. Blackbird Creek has been subject to a loss of biodiversity over the past several decades due largely to the increasing prevalence of the common reed (Phragmites australis). Subsequently, the area has seen a large degree of management in the form of marsh vegetation restoration. This study aims to evaluate whether or not an increase in the relative abundance of P. australis has a deleterious effect on available blue crab habitat. Sites for blue crab sampling have been selected based on 3 treatments: Spartina alterniflora dominated, P. australis dominated, and sites with a mixed array of vegetation. An otter trawl and crab traps are being utilized in the sampling at all locations on a weekly basis from May through November and the sex, carapace width (mm), maturity stage, and molt stage of each individual is recorded. Identification, size, and abundance of all bycatch has also been recorded. White perch showed variation across the sites but were consistently the most abundant fish species at all sites. A chi square test ($x2 = 306.22$, $df = 5$, $p<.001$) revealed that blue crab abundance was significantly different between our sites, with juvenile crabs being the most abundant at one of our S. alterniflora sites where molting also occurred more frequently. Males outnumbered females ($x2 =17.5$, $df=5$, $p<0.001$) in the study area with average CW from Spartina, Phragmites, and intermediate Phragmites invasion sites ranging from 75, 106 and 113 mm, respectively.

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AUTONOMOUS ADAPTATION OF SALINE COASTAL WETLANDS TO CLIMATE CHANGE: CHALLENGES AND OPPORTUNITIES IDENTIFIED FROM SOUTHEASTERN AUSTRALIA

Climate change, particularly sea-level rise, will impact saline coastal wetlands in southeastern Australia and alter the ecosystems services they provide. We present a case study from the Hunter River estuary which demonstrates that climate change provides a number of challenges to the management of saline coastal wetlands. Geospatial evolution models indicate coastal wetlands may have some capacity to respond to sea-level rise through autonomous adaptation processes that increase the soil volume, or by migration to new locations where their intertidal position is maintained. However, migration may be limited by available accommodation space or existing infrastructure; and in some cases, past management actions that limit tidal exchange to viable land (e.g. flood gates) may profoundly limit the capacity of wetlands to migrate. In particular, we found only 33% of the potential wetland area identified in 2007 remained under a high sea-level rise scenario with floodgates closed in 2100, while there was 127% expansion of potential wetland extent with floodgates open and levees breached. Existing processes that increase the soil volume exhibit a threshold which is inversely proportional to the rate of sea-level rise. However, facilitating expansion of the soil volume beneath coastal wetlands and expansion of coastal wetlands through migration has the additional benefit of sequestering carbon and increasing the ecosystem services provided by coastal wetlands. To ensure the continued provision of ecosystem services, management and policy action is required to ensure coastal wetlands can adapt. In particular, we recommend that static conservation measures, such as National Parks and Ramsar sites, employ dynamic buffers to accommodate adaptation of coastal wetlands to sea-level rise. The costs of facilitating adaptation, such as land purchases, may be offset by carbon sequestration gains as wetland areas expand.

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SHELLFISH AQUACULTURE IN THE COASTAL ENVIRONMENT: POTENTIAL FOR NUTRIENT MANAGEMENT AND CHALLENGES TO IMPLEMENTATION

The use of shellfish aquaculture for nutrient remediation is under discussion within the USA and abroad. A combination of pilot-scale research, modeling, policy, and outreach is being used to explore opportunities at the system scale within Long Island Sound, USA. Research indicates that shellfish filtration can be substantial in areas highly impacted by human activity, but careful site selection is essential to maximize nitrogen removal by an aquaculture installation. A site selection process is being developed that takes into account use conflicts, environmental impacts, site characteristics, and water quality-based predictions of farm productivity. Models suggest that nitrogen removal by shellfish farms compares favorably to agricultural and urban stormwater BMPs in terms of cost per unit nitrogen removed. Discussions are underway with regulators regarding the incorporation of shellfish aquaculture into a larger nitrogen management program. Outreach efforts include a website, fact sheet, presentations, and popular news articles. Results indicate considerable potential for shellfish aquaculture as a new addition to existing nitrogen management programs, but challenges to implementation must be overcome. Social constraints on the expansion of shellfish aquaculture in the coastal environment are substantial. New markets for expanded production of commercial product need to be identified. Barriers to permitting this new type of activity in the coastal environment will need to be reduced. Shellfish used may be subject to prohibitions related to human consumption based on high levels of indicator bacteria, and sites may also contain high levels of chemical contaminants. The use of alternative species, not for human consumption, is being explored to address this issue, as well as the

development of markets for these non-commercial species. Opportunities for paying farmers for the nitrogen removal services they provide should also be explored.

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ACCRETION, SEDIMENT DEPOSITION AND SUSPENDED SEDIMENT DYNAMICS IN MUGU LAGOON, A SOUTHERN CALIFORNIA COASTAL ESTUARY

To protect and restore salt marsh in the face of predicted sea level rise and extreme weather patterns, there is a need to understand vertical accretion, the aggregation of material on a wetland surface, which depends on organic matter accumulation and mineral sedimentation. Our study is one of the first to characterize spatial and temporal variation in sediment dynamics for a salt marsh not dominated by *Spartina* species. We measured suspended sediment concentrations, sediment deposition and vertical accretion rates in four marsh zones in the central basin of Mugu Lagoon, a salt marsh dominated by *Sarcocornia pacifica* . Suspended sediment concentrations (as Total Suspended Solids [TSS]) was 21±1 mg l^{-1} (Mean±SE) between February and May 2012, which is within the middle of the range previously observed for other salt marshes. Mean sediment deposition ranged from 0.00 g m^{-2} day^{-1} to 1.29 g m^{-2} day^{-1}, which is in the low end of the range previously observed for other salt marshes. We observed no net accretion during a study period with below average rainfall and extended dry periods between five storms (~3 cm of precipitation). Sedimentation was highest adjacent to the creek for high and high-mid marsh zones. Contrary to patterns observed in previous studies, organic matter concentration in TSS varied with tide height, but mineral content did not. An improved understanding of sediment transport and deposition, can improve the management, enhancement and restoration of these invaluable resources, preserving their ecosystem services and functions for future generations.

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RESPONSE OF SURFACE TURBULENCE STATISTICS TO A SUBMERGED CANOPY

Remote detection of coastal hydrodynamics is challenging because submerged characteristics are significantly obstructed by the overlying water column and its biological/ sedimentological load. Remotely observable surface turbulence may provide insight into subsurface processes, but the fundamental theory necessary to link these two domains is not yet fully developed. In channel flows, surface turbulence can be linked to the hydrodynamic characteristics of the water column. Much work in the past decade has focused on using coherent turbulent structures for insight into subsurface flow characteristics. These features form near bedform irregularities but can be advected upward through the water column. When they reach the surface, they generate signature expressions such as upwellings, downwellings, and counter-rotating vortices. However, these expressions are difficult to distinguish from a larger collection of surface turbulence features, such as those generated through wind and wave activity. These coherent structures can even be obscured within the background turbulence produced by standard bottom boundary processes. Rather than rely upon explicit identification of individual coherent events, this work follows the example of recent numerical modeling work which has looked at stochastic representations of the surface turbulence field. Among the feature classes of bedform irregularities, submerged vegetation is of particular importance in coastal and estuarine systems. Submerged vegetation attenuates incoming tidal and wave energy, plays a crucial role in determining sediment transport, and contributes significantly to local gas exchange with the atmosphere. In this poster, we explore the relationship between unidirectional flow and submerged vegetation by varying flow conditions over a model canopy. The responses of surface turbulent statistics - measured using surface particle image velocimetry - to changes in flow speed and canopy properties are presented.

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MARINE DEBRIS IN CENTRAL CALIFORNIA: COMPARING A BASELINE SURVEY TO RECENT MONITORING TACKING TSUNAMI DEBRIS IN MONTEREY BAY, CA

Monitoring beach litter is essential for reducing ecological threats towards humans and wildlife. In Monterey Bay, CA, information on seasonal and spatial patterns is understudied. Central California's coastal managers require reliable information on debris abundance, distribution, and type, to support policy aimed at reducing litter. We developed a survey method that allowed for trained citizen scientists to quantify the types and abundance of beach litter. Sampling occurred from July 2009–June 2010. Litter abundance ranged from 0.03 to 17.1 items m^2. Styrofoam, the most numerically abundant item, made up 41% of the total amount of litter. The results of this study provide a baseline on the types and abundance of litter on the central coast and have directly supported policy banning Styrofoam take out containers from local municipalities. Since the completion of this study, tsunami induced marine debris from Japan has been accumulating on the West Coast and a few potential sightings of debris have been documented around the Monterey Bay. This past year, the National Oceanic and Atmospheric Administration coordinated a volunteer-based beach litter monitoring effort to address tsunami debris that may wash ashore. In our post-hoc assessment of this continued monitoring, we analyze two survey sites using results from our baseline 2009-2010 study, and comparing them to the NOAA July 2012–June 2013 survey. We expect to see noticeable differences between sites in respect to litter type and abundance. Continued monitoring in the Monterey Bay enables us to carry on previously achieved political successes and can further help us identify potential human and ecological threats from litter washing ashore.

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INTERPRETING SHALLOW WATER TURBULENCE MEASUREMENTS: DECIPHERING THE MUDDLE CAUSED BY WAVES

Turbulence affects the distributions of dissolved and particulate materials including salt, nutrients, plankton, and sediment both directly, through turbulent dispersion, and indirectly, via its effects on currents. Quantifying turbulent mixing is therefore important for understanding and predicting many physical, chemical, and biological processes in coastal and estuarine systems. In shallow water, turbulence is often measured using sensors that resolve velocity and scalar fluctuations at high temporal resolution, but only at a single fixed location in space. Surface waves advect turbulent eddies past these sensors and the resulting time series are difficult to interpret. Turbulent fluxes and dissipation rates can be over-estimated by more than an order of magnitude if waves are not correctly taken into account. To improve understanding of the effects of waves on turbulence measurements, we performed idealized simulations in which turbulence with known spatial structure was advected past a fixed "sensor" by wave orbital motion. Turbulent velocity fields were obtained from direct numerical simulations (DNS) of isotropic turbulence as well as simulations of smooth and rough turbulent boundary layers. These spatial turbulence fields were advected and distorted by wave orbital velocities corresponding to both monochromatic and random waves, and velocity time series observed at a fixed point were extracted. Using these simulations, we tested methods that are commonly used to estimate turbulent fluxes and dissipation rates from field measurements. These analyses were used to assess conditions under which common assumptions break down, and to develop new methods for estimating Reynolds stresses and scalar fluxes, dissipation rates, and turbulent length scales from field measurements containing waves.

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SHORT- AND LONGTERM EFFECTS OF MECHANICAL DISTURBANCE OF SHALLOW HARDBOTTOM BENTHIC COMMUNITIES IN NE BALTIC SEA

Among different types of pressures shaping the structure and dynamics of shallow hardbottom communities in the Baltic Sea mechanical diturbance is one of the strongest and at the same time most difficult to predict. In the conditions of NE Baltic Sea mechanical disturbance of shallow benthic communities can occur e.g. by effect of ice scouring or human induced activities. Ice scouring has a very irregular character, depending very much on climatic conditions of particular year (extent and duration of ice cover varies from year to year). Also depth extent of afected seafloor can vary. So this pressure is very unpredictable while the effect on the structure of the communities is very strong. Similar effect has human activity e.g. in cases of large scale construction excercises. We studied short- and long-term effect of mechanical disturbance of seafloor communities at different depths in the photic zone in order to evaluate the possible impact of construction of gravitational foundations of planned offshore windpark on remonte offshore bank in NE Baltic Sea. Our experiments included mechanical damage of limestone seafloor communities and then following the recolonisation of treated plots. Treatments were replicated in different depths and different seasons. Results showed that recolonisation patterns depended both on the depth and the toiming of disturbance. During first vegetation season the difference between treated plots and control communities remained very high at larger depth (close to the limit of photic zone) while in shallowest treatments community qualitative and quantitative structure almost restored. Longterm observations reveiled the longlasting effects even arter four years period. Results of this investigations will help to assess better the possible environmental impacts of large scale construction projects and also will help to predict possible changes in benthic hardbottom communities connected to climate change.

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INTEGRATED APPROACH TO ASSESS AND FORMULATE RESTORATION MEASURES IN THE CHENIER PLAIN, LOUISIANA

The Chenier Plain region is located in southwestern Louisiana. It covers 5,289 km^2 and has a landscape with a diverse composition from marsh to industrialized port and city infrastructure. The Chenier Plain includes a network of channels, canals and structures (e.g., spillways) that regulate the surface water flow. Thus, understanding the hydrologic processes is needed to continue designing and building successful restoration projects and implement management strategies based on existing and future conditions along the coast. The Chenier Plain has benefitted from projects whose aim was to construct small spatial scale measures to improve or restore hydrology, marshland or other natural features of the region. These measures were analyzed and designed using site-specific tools (i.e., site-specific data collection and numerical models). The Coastal Protection and Restoration Authority (CPRA) in their 2012 Master Plan and recently in a regional feasibility study adopted an integrated approach to analyze and formulate restoration measures. This approach is developed to understand the effects of a single measure on a localized area and to assess interactions among various measures. This approach encompasses a large-spatial domain and analyzes the measures over a 50-year time scale. These spatial and temporal scales allow for investigating short-term hydrologic and long-term vegetation, morphologic and other ecologic processes. Such an approach provides information and insight to engineers, scientists, managers and planners such that they can assess the benefits of proposed restoration measures individually and collectively. The integrated analysis approach is based on the use of modeling tools (hydrology, water quality, vegetation, and wetland morphology) supported by a strategic data collection program. The focus of the refinement of the models is to enhance their ability to capture spatial and temporal variability of physical and ecological processes of the region.

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FIFTY YEARS LATER: RE-EXAMINING THE CULTURAL EUTROPHICATION PROBLEM IN RARITAN BAY, NJ USING ENVIRONMENTAL MONITORING AND MULTIVARIATE ORDINATION TECHNIQUES

The Hudson-Raritan estuary (HRE) of New York and New Jersey is one of the most urbanized estuaries, and busiest ports, in the world. Raritan Bay, in the southeastern portion of the HRE, has a long history of cultural eutrophication and associated harmful algal blooms (HABs). Despite the striking chemical and biological alterations that are occurring in Raritan Bay, publications from ~50 years ago were the last to report long-term, consecutive measurements of both water quality parameters and plankton species composition in this system. The objectives of this study were to establish a monitoring program to characterize water quality trends in a eutrophic estuary, compare current environmental conditions and plankton composition to those documented in Raritan Bay fifty years ago (i.e., at the same six sampling sites), and to further clarify the relationship among nutrients, secondary consumers, and algal bloom generation in this system using ordination techniques. Monthly data collection extended from April 2010 through October 2012. Nitrate (N) and soluble phosphorus (SRP) concentrations are as much as 50 and 20 times higher, respectively, than concentrations reported in the literature fifty years ago. A total of 14 HAB species have been identified, including Heterosigma akashiwo, which formed a bloom in the upper Raritan Bay during summer 2012 in association with hypoxic conditions. Multivariate analyses indicate that abundance of this potentially harmful species is positively associated with high temperature, salinity, N, and SRP and negatively associated with spring river discharge rates and total zooplankton abundance in Raritan Bay. The data suggest that precipitation and river discharge, particularly in association with Atlantic hurricane season (e.g., Tropical Storm Irene), play an important role in controlling plankton composition and bloom formation.

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SOCIETAL PHOSPHORUS METABOLISM IN A COASTAL REGION DURING A PERIOD OF POPULATION MIGRATION AND ECONOMIC INSTABILITY

The global phosphorus (P) cycle has been significantly altered by humans in past decades, contributing to the eutrophication of coastal waters. Accounting for anthropogenic nutrient cycling remains a critical task, increasingly in the context of food security for P due to the finite availability of phosphate rock. We utilize material flow analysis to examine societal P metabolism in a 7-parish region of the upper Lake Pontchartrain Basin in coastal Louisiana. Mass balances encompass annual human-mediated P fluxes in agricultural, forested, and developed lands (incl. wastewater). The study region has experienced an influx of residents following devastation wrought by Hurricane Katrina in the lower basin in 2005. Furthermore, instability in fertilizer prices during 2005-2009 influenced the availability of P fertilizer to local agricultural and forestry sectors. We examine P cycling in the region for a pre-Katrina, pre-recession period (2000-2004) and for a post-Katrina, recession period (2005-2009). Inputs to agricultural and forested lands decreased from 3482 to 2100 Mg P y^{-1} between periods. Dramatic decreases in purchased P fertilizer (71% decrease between periods) were correlated to increases in fertilizer prices. Flows of P to developed lands increased from 1596 to 1941 Mg P y^{-1} between periods due to the influx of new residents. Leakage to Lake Pontchartrain and the Mississippi River (674-838 Mg P y^{-1}) represented 14-15% of total inputs. The vast majority of total inputs accumulated within the watershed (~80%) including 562-1237 Mg P y^{-1} that can be considered recoverable under current practices. Less than 6% was confirmed to be actively recycled or exported as products. We examine the implications of our findings for coastal regions influenced by environmental change and resource limitation. Finally, we discuss opportunities to effectively close the coastal human P cycle by increasing the intensity of P recycling and minimizing losses to coastal waters.

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RISING TIDES AND CHANGING ATTITUDES: COMMUNITY ADAPTIVE PLANNING AND BEHAVIOR CHANGE IN NORTH KINGSTOWN, RHODE ISLAND

Consequences of global climate change including sea level rise and more intense storms are likely to cause significant impacts on ecosystems and critical infrastructure in vulnerable coastal municipalities. As a small state with a large coastal population, Rhode Island is highly vulnerable to economic and social losses resulting from climate change impacts unless coastal communities proactively engage in adaptation planning. It is clear that actions must be taken, however implementing effective policy changes requires significant political will as well as the support of decision makers and communities. Municipal officials' perceptions of the risks from sea level rise and increased storminess are key to proactive planning. This case study of North Kingstown, Rhode Island analyzes the

relationship between town decision makers' understanding of climate change and sea level rise risks and adaptive planning behavior. The results provide insights for those working with decision makers to proactively incorporate adaptation actions in town comprehensive and capital improvement planning. Results of this research indicate no correlation between local decision makers' levels of climate change knowledge and their individual preparatory behavior or between personal adaptive behavior and levels of support for proactive municipal adaptation. However, a strong correlation was found between individuals with mental models closely matching the expert model of climate change and the associated risks and levels of support for municipal adaptation planning and actions. Additionally, a moderate correlation exists between decision makers' exposure to climate change information and levels of support for municipal adaptation. Increasing awareness of the specific risks associated with impacts of climate change through communication, educational programs, and public outreach is likely to be effective in promoting proactive adaptation in vulnerable coastal communities.

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THE INFLUENCE OF CLIMATE CHANGE ON SUBMERGED AQUATIC VEGETATION TRENDS IN THE CHESAPEAKE BAY

Submerged aquatic vegetation (SAV) are an integral part of a marine ecosystems biological and physical processes. Like many aquatic species, SAV are highly sensitive to changes in environmental conditions. Changes such as water temperature, flow, increased number and intensity of storm events, and declines in water clarity due to excess nutrient and sediment loading are causal links to the decline in SAV. SAV is monitored in the Chesapeake Bay as an indicator of segment by segment incremental progress towards the attainment of water quality standards (WQS). The 91 applicable segments of the Chesapeake Bay are monitored for percent attainment of their SAV (best of SAV/clarity after 2006) restoration goals set by the WQS per jurisdiction. Climate change is going to present an additional challenge moving forward towards those goals, and this study shows SAV attainment of WQS trends in the Chesapeake Bay linked to causal effects of climate change, using data from 1985-2011 collected by the Chesapeake Bay Program's water quality monitoring program and the Virginia Institute of Marine Science. This study evaluates the additional obstacle of climate change facing the progress of SAV goal attainment and the biological change in species composition due to the state of water quality. Seventeen species of SAV are commonly found in the Chesapeake Bay among the most abundant are; widgeon grass (Ruppia maritime), wild celery (Vallisneria americana), hydrilla (Hydrilla verticillata), and eelgrass (Zostera marina), all with different limits to demonstrate the changes in each segment over time. Results found in this study vary by segment.

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SECONDARY PRODUCTION OF THE BENTHIC COMMUNITY ASSOCIATED WITH *ZOSTERA MARINA* IN PUNTA BANDA COASTAL LAGOON, ENSENADA, BAJA CALIFORNIA, MEXICO

The secondary production is an important measure to evaluate the health and trophic dynamics and is important to determine the ecosystem services of any marine ecosystem. During a 2010 bimonthly samplings of benthic community were taken in a Zostera marina seagrassbed. In order to estimate the secondary production of the benthic community of Punta Banda coastal lagoon, located in the southeast of the Ensenada city, Baja California, Mexico. A total of 4830 organisms were collected and classified in 11 phyla. The density ranged from 7256 to 79739 ind.m-2. The secondary production estimated with equivalences proposed by Crisp (1984) was 31.67 g AFDW m2y-1. The highest production was found in July (13.78 g AFDW m2) and the lowest in September (2.52 g AFDW m2). Sieve effectiveness was also tested among 9 different sieve sizes. Sieve size of 5.6 mm was the most important because retains the biggest organisms. The Kruskal-Wallis test demonstrated significant statistical differences between sieves of 5.6 mm with 500μm, and with 355 μm ($p= 0.0001$), the same test showed no significant differences among months ($p= 0.14$). The Spearman correlation analysis test showed a high value with the chlorophyll of the bay (0.90). We have the suggest that secondary production could be favored by a synergy complex between the phytoplankton community from the bay that enters daily to the coastal lagoon at high tide and the Zostera marina seagrassbed that works like a trap for phytoplankton and nutrients.

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IS RECENT SALTMARSH ACCRETION RELATED TO SEA LEVEL CHANGE? EXAMPLES FROM MEXICO

Sea level change has been monitored for well over one century in a few locations of the occidental world, and with more density during the last few decades. Although this provides a good estimation of global eustatic sea level, this not homogeneous and does not reflect local sea level change affected by other factors. Furthermore, satellite altimetry has been providing high-spatial resolution sea level data, thus valid for local sea level change estimations, but only for about the last decade. Finally, work has been done to provide long- and medium-term records by studying foraminifera in saltmarsh sediments around the world. In this work we revise and discuss the use of recent (<100 yr) marshland sediment accretion, obtained from 210Pb sediment dating, as a proxy of local mean sea level change. This methodology could provide mean sea level change records for the last 100 yr from any region in the world.

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HABITAT LOSS AND CONVERSION OVER THE PAST 150 YEARS IN 30 BAR BUILT ESTUARIES THROUGHOUT CALIFORNIA

The Central Coast Wetlands Group has been working on a project for USEPA since 2009 to study Bar-Built Estuaries in California. These systems, commonly called lagoons, have faced anthropogenic land-use stressors that range from the impacts of logging to construction of freeways, intense urbanization to altered hydrology. One aspect of the project was a historical analysis of 30 sites spanning the entire Coast of California, comparing mid to late 19th Century US Coast Survey Topographic Sheets (T-sheets) to current day aerial photographs. Developing a scientifically valid and repeatable process for this analysis was challenging, as a flawed process could create misleading results. We followed guidelines from previous studies of T-sheets (SFEI, SCCWRP, 2nd Nature and others); but adjusted techniques to reflect the complexities of bar-built estuary component habitats. In ArcGIS, we used rectified T-sheets to align with current aerials for each of the chosen sites. Once in place, wetland extent and habitat polygons were created for both maps at each site, and labeled in the Attributes Table. Thus, area could be calculated for each polygon, and then compiled at each site by habitat type. Four levels of attributes were created to allow for a broader range of possible breakdowns than is typically seen in a T-sheet analysis. By comparing the area of both current and historical polygons, we were able to quantify the habitat loss and conversion that has taken place at each site. Results provide an insight into which habitat types and associated lagoon functions are most endangered in various regions of the State. This information can lead to a big picture understanding of these systems not only as individual sites, but also as a suite of systems which historically provided a suite of environmental services that may not exist today.

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CARBON SEDIMENT POOLS AND SEQUESTRATION RATES IN THE SNOHOMISH RIVER ESTUARY, WASHINGTON

Recent attention has focused on exploring the carbon storage and sequestration values of wetlands, to mitigate greenhouse gas emissions, especially tidal wetlands. Efforts are now underway to develop the tools and refine the science needed to bring carbon markets to bear on tidal wetland restoration activities. While the high carbon storage and sequestration values of tidal wetlands are known for some coastal systems, if wetland restoration projects are to become viable as greenhouse gas projects, a translation of these carbon values to an estuary restoration and protection setting needs to be created. To this end, this project focuses on the Snohomish River estuary of the Puget Sound, Washington, which offers a continuum of wetlands including seasonal floodplains, open mudflats, mature and tidal forests, and salt marsh habitats. In addition, there is strong restoration potential in a suite of ongoing and proposed projects. One objective of this project is to conduct a field investigation to broadly quantify the carbon stocks within representative ecosystems of the Snohomish estuary. This aspect of the project will result in site-specific, field-verified carbon values in place of estimates based on literature values, leading to a more robust study, with broader application and make a contribution to the growing body of international literature on carbon pools in differing wetland types. To accurately quantify the sediment carbon pools, two parameters must be quantified; bulk density and organic carbon concentration with depth. To estimate rates of carbon storage, we must also quantify long-term (100 years) rates of sediment accretion. We report here on the carbon storage pools, and estimated rates of carbon storage, derived from sediment cores collected at representative sites within the Snohomish estuary during the spring and summer of 2013.

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MANGROVE EXPANSION INTO SALTMARSH IN SE AUSTRALIA

Over 30 published accounts of mangrove encroachment into saltmarsh have established a near ubiquitous regional trend, with estimates of up to 30% of saltmarsh lost to mangrove in the past 50 years across several thousand kilometres of coastline. Studies applying the Surface Elevation/Marker Horizon technique have implicated relative sea-level rise as a driver of change in southern estuaries, while studies in Queensland have shown a correlation between the proportion of mangrove and saltmarsh and rainfall patterns. We describe the different ecological goods and services provided by mangrove and saltmarsh in the region, including habitat provision, and carbon sequestration.

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THE EFFECTS OF HABITAT DEGRADATION ON REEF ACOUSTIC CUES AND FISH MOVEMENT

Habitats are linked by animal movement yet we lack a comprehensive understanding of how anthropogenic disturbances alter this connectivity. Movement is generally guided by the use of environmental cues to increase the likelihood of an animal locating a suitable habitat. Human induced habitat alteration can change these cues, thereby potentially changing how habitats are linked across the land/seascape. We are investigating these ideas in the tropical coastal ecosystem composed of the distinct yet joined habitats of coral reefs, mangroves, and seagrass. These habitats are connected in part by the movements of fish that undergo ontogenetic niche shifts from the nursery habitats of seagrass and mangroves to the adult coral reef habitat, impacting fish biomass on the reef and recovery after disturbance. We hypothesize that 1) juvenile fish of the species Haemulon flavolineatum use acoustic cues at least partially for orientation to coral reefs, 2) orientation to an acoustic cue will depend on its power spectral density, specifically the power associated with low frequency fish vocalizations, and 3) the cue's detectability at nursery habitats is dependent on the condition of the source reef, habitat configuration, and ambient noise. To determine if the fish respond to cues from a relatively healthy reef we conducted experiments using juvenile fish in a binary choice chamber with sounds recorded at reefs with relatively high fish abundance and coral cover. We also conducted experiments using sounds from reefs in poor condition to determine if response is dependent on spectral characteristics of the cue. In order to investigate cue detectability we compared sound recordings from reefs in poor and relatively good condition and investigated the propagation of these sounds from reefs to nursery habitats. Evidence of acoustic cue use during habitat transitions and seascape level variability in these cues would be valuable in the management of these coastal habitats.

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INFLUENCE OF TURBULENT BURSTING ON SEDIMENT ENTRAINMENT ON THE CONTINENTAL SHELF

In classical sediment transport theory, it is postulated that a critical velocity needs to be exceeded prior to sediment re-suspension and transport occurs. However, recent studies have shown that, in low energy environments (e.g. deep sea) this critical velocity is rarely exceeded, yet transport occurs. This suggests that there are some factors other than the mean current velocity that contribute to sediment movement under these conditions. This research intends to develop a better understanding of the role of intermittent turbulence near the seabed in transporting sediments along the bottom boundary layer of the continental shelf. The proposed study will examine the mechanisms underlying sediment re-suspension and improve our understanding of how the 'bursting phenomenon' generates as well as providing a more refined parameterization of essential sediment transport processes in continental shelf flow environment. With collaborative help of oil and gas companies through the South East Asian Scientific & Environmental ROV Partnership using Existing Industrial Technology (SEA SERPENT) project, remotely operated vehicle (ROV) was used to deploy an ADV instrument on the sea floor. Primarily, data sets have been collected from 61km north-west shelf off Barrow Island, Western Australia at 225m water depth with 4Hz sampling rate. The field data were analysed to examine the significance of the role of turbulent bursting phenomenon in the re-suspension process of sediment in low mean currents.

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UNDERSTANDING PROCESSES CONTROLLING OMEGA AT THE UNH CO2 BUOY SITE USING A DECADE OF HIGH FREQUENCY OBSERVATIONS

The commercially valuable coastal Gulf of Maine is known annual high productivity, a large range in annual temperatures, receives considerable local discharge and is the site of intense mixing by tides and wind. The UNH coastal carbon group has been measuring carbonate system parameters at a site in the western Gulf of Maine since 2004. Using simple one dimensional models driven by high frequency data, we deconvolve processes controlling the saturation index of aragonite (Omega). We find as expected, that Omega is controlled seasonally by variability in temperature and net biological productivity. However, we also find that the air-seas flux of inorganic carbon and mixing - both lateral and vertical, also play critical roles in controlling Omega. We note that within our decade of observations, the intensity of processes over annual scales appears to mask any change in Omega caused by a secular change in atmospheric CO2 over the decade.

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SYNERGISTIC EFFECTS OF ALTERED SALINITY AND TEMPERATURE ON EELGRASS (*ZOSTERA MARINA*) SEEDLINGS AND ADULT PLANTS

Salinity and temperature are among the most important factors determining eelgrass distribution and performance. Ongoing climate changes are expected to alter both the salinity and the water temperature in estuarine and coastal waters. In the present study we investigated experimentally how the performance and survival of adult plants and seedlings is affected by the combined effect of altered salinity and temperature projecting some of the future climate scenarios. We conducted a 5-week aquarium experiment with different combinations of salinity (5, 12.5 and 20‰) and temperature (15, 20 and 25°C). Both seedlings and adult plants responded negatively to altered salinity and temperature with seedlings being more sensitive than adult plants. Altered salinity and temperature had synergistic effects on eelgrass survival and performance. Specifically, increased temperature in combination with decreased salinity resulted in higher mortality and lower number of leaves per shoot compared to salinities and temperatures close to the ambient conditions. Leaf tissue sucrose concentrations in both life stages decreased at low salinity, whereas salinity and temperature resulted in contrasting starch concentrations between seedlings and adult plants. Our results show that altered salinity and temperature may affect eelgrass performance, especially when considering future climate scenarios. As seedlings appear to be more sensitive to salinity and temperature stress than adult plants, the future climate changes are likely to alter meadow population dynamics emphasizing the higher importance of vegetative reproduction in the future.

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ZOOPLANKTON COMPOSITION AND ABUNDANCE IN A SUBTROPICAL ESTUARY (PARANAGUá BAY, SOUTHERN BRAZIL)

The Paranaguá Estuarine System (PES) is one of the most important estuarine environments of the Brazilian coast, but its zooplankton community is poorly known. This study aims to describe the zooplankton fauna from PES during the summer of 2012 by evaluating its composition, density and spatial distribution. Samples were taken with a cylindrical-conical net (200 μm mesh), equipped with a flowmeter and obliquely towed along 37 sampling stations. Salinity ranged from 20 to 34 and the water temperature was 28°C in average. The subclass Copepoda represented 96% of total zooplankton. The spatial analysis based on the taxonomic composition (nMDS and ANOSIM) showed significant differences between different estuarine areas. Marine eurihaline species were especially important in the outer portions where salinity values were higher, such as Oncaea waldemari and Temora turbinata, considered an invasive species to Brazilian coastal, probably by ballast water. Typical estuarine species, especially Oithona oswaldocruzi, Pseudodiaptomus acutus and Acartia lilljeborgi, were abundant in the innermost regions, where salinity ranged from 24 to 28. Other important groups were Chaetognatha, Appendicularia and Decapoda larvae. The highest total densities (maximum of 51,570 ind.m-3) were found in intermediate polihalines stations of Paranaguá bay, directly related to peaks of abundance of the most important copepods, especially O. oswaldocruzi and A. lilljeborgi. In contrast, the lowest values were recorded mainly in the innermost areas of the bay (minimum of 1,055 ind.m-3).These results may be associated with the hydrodynamic and hydrological features of the PES, since the highest zooplanktonic densities were coincident with nutrients concentration and chlorophyll-a observed by previous studies for summer periods. The effects of anthropogenic eutrophication on the zooplankton abundance should be also investigated in further studies.

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EFFECT OF TEMPORAL VARIATIONS OF RIVER DISCHARGE AND WIND-STRESS ON THE POSITION OF SALT WEDGE IN A MICRO-TIDAL RIVER MOUTH

Hydrographic data from three 25 h surveys developed in a sub-tropical micro tidal estuary, reveled the effect of river discharge (Q) on the presence-absence of the salt wedge as well as the short term response of salt intrusion to wind and runoff pulses. This subtropical region, southwestern part of Gulf of Mexico, is characterized by well defined dry, wet and "northerly wind" seasons. The latter, shows northerly wind events (locally named "nortes") relatively strong (>10 m/s) and of short duration (3 to 5 days long) that are associated with the passage of cold fronts. The daily average discharge commonly exhibits strong pulses of few days, associated either with the passage of cold fronts or with incursion of tropical storms and hurricanes. The surveys took place during dry, wet and "nortes" seasons, they occurred from April 2010 to January of 2011. The main findings can be summarized as follow: (1) The salt wedge will be present if Q < mean annual river discharge. (2) The salt wedge displacement due to the tidal forcing is about 1-2 km. (3) The salt wedge responds over short time scale (order of hours) to wind and runoff pulses. (4) Both, down-estuary (local action) and N-winds (along-shore, remote action) enhance salt wedge intrusion and overwhelm the tidal effect on the salt wedge position.

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AN ADH MODEL TO SUPPORT THE HYDROLOGIC RESTORATION OF COLE'S BAYOU, TECHE-VERMILION BASIN, LOUISIANA

The Cole's Bayou marsh restoration site is located on the Gulf Coast of Louisiana in Vermilion Parish within the Teche-Vermilion Basin, immediately east and south of the Freshwater Bayou Canal. Wetlands in Cole's Bayou are experiencing land loss at a rate of 0.42% per year due to subsidence, sediment deficit, interior ponding and pond enlargement, and rapid episodic losses due to tropical storms. Additionally, significant interior marsh loss has resulted from saltwater intrusion and hydrologic changes associated with increasing tidal influence and changes in water quality. As hydrology in this area has been modified, habitats have shifted more floatant marsh resulting in increased vulnerability to tidal energy and storm damages. One key component to hydrologic restoration is to increase freshwater and sediment inflow into interior wetlands by altering inflow channels and other areas near the head of the marsh. A hydrodynamic model of the Cole's Bayou project area and the surrounding waters including Little Vermilion Bay, Freshwater Bayou, and Vermilion Bay was constructed using the ADaptive Hydraulics Model (ADH). ADH has proven to be a reliable tool for coastal, estuarine, and marsh modeling because of its ability to deal with intricate domains of varying scales, efficiently handle complex wetting and drying, and simulate hydraulic structures. Six data sampling stations were deployed to collect water level, salinity, and turbidity data necessary to develop and validate the model. Suspended sediment samples were taken hourly over a tidal cycle at each station during a frontal event, a high-wind event, and baseline conditions. Nutrient samples were taken monthly within the marsh. The field data combined with results from the hydrodynamic model will estimate the effects of hydraulic alterations of sediment and nutrient loading into the project area. This will enable managers to ascertain the impacts of system alterations on marsh creation within Cole's Bayou.

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CONSIDERATIONS ON THE USE OF RECENT SALTMARSH ACCRETION AS A PROXY OF SEA LEVEL CHANGE

Although sea level is instrumentally monitored, existing records are either too short (e.g. satellite altimetry) or too sparse (tide gauges), and not exempt of problems. Saltmarsh accretion rates derived from 210Pb chronology is, potentially, a powerful methodology to obtain 100 yr records of mean sea level change in most coastal regions worldwide. In this work, we use examples to review the application of several 210Pb dating methods to derive saltmarsh accretion rates. Also, we discuss limitations due to sampling artifacts and the sedimentary record time resolution. Special emphasis is given to the full estimation of uncertainties by quadratic propagation and a Monte Carlo method.

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POST-GLACIAL EXPANSION AND POPULATION GENETIC DIVERGENCE OF MANGROVE SPECIES *AVICENNIA GERMINANS (L.)* STEARN AND *RHIZOPHORA MANGLE (L.)* ALONG MEXICAN COAST

Mangroves are highly productive tropical ecosystems, that support numerous food chains in the coastal zone and neighboring ecosystems. For tropical species, future climate change could provide suitable habitat at higher latitudes providing the opportunity for them to expand their range limits. Understanding the response of mangrove species to climate change is of utmost importance for the management of coastal resources. Genetic diversity, connectivity and population genetic structure of two widespread mangrove species (A. germinans and R. mangle) was analyzed in Mexican mangrove forests. They both mangrove species showed a decreasing trend in genetic diversity northward Gulf of California, where mangrove populations are more stressed by natural and anthropogenic disturbances. Continuous populations like mangrove forests at Atlantic coast are prone to have more genetic diversity and lower levels of genetic structure compared with discontinuous distribution at range limits on Pacific coast. It is also assumed that historical changes in temperature due to glacial events have led to recent colonization and re-colonization of mangrove populations at range limits from Marismas Nacionales and southern populations. Also important is that genetic diversity is not randomly distributed; rather it is significantly structured in small population units along Pacific coast. Geographical barriers seem to have a high impact over genetic differentiation since we observed that populations from Atlantic and Pacific coast were more different as a result of isolation by uplift of Panama isthmus. This study contributes to our understanding of mangrove populations and gene flow in the Mexico and underlines the importance of genetic conservation to maintain the success of the mangrove ecosystem along the Mexican coast in future management and conservation plans of this natural resource.

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COLLABORATIVE SCIENCE-BASED LOADING ESTIMATES FOR USE IN MANAGEMENT DECISIONS

Recent hypoxia events along the coast of South Carolina in the Long Bay portion of the South Atlantic seaboard have prompted additional concerns regarding the source of materials fueling hypoxia in the bay. This portion of Long Bay receives stormwater runoff from the well-known tourist destination of Myrtle Beach. Stormwater runoff from this urbanized area primarily drains into Long Bay via tidal creeks (locally known as swashes), beach-front and ocean stormwater outfalls. The local municipalities are interested in making science-based management decisions but they lack the information necessary, especially concerning the concentrations of material being input into Long Bay. Scientists and managers have been working together to identify and implement a research project with the goal of developing this science-based information. Fifty-eight watersheds for the 16 swashes, 6 ocean outfalls, and approximately 69 beach-front outfalls have been delineated using data provided by the four major municipalities in the Myrtle Beach area. Through a facilitated discussion, the managers and scientists identified two representative swashes to sample for an intensive two year study of the materials (nutrients, organic matter, limited indicator bacteria) leaving the watersheds via dry and wet events. Understanding the loading of materials from each of these watersheds is critical to understanding the major sources (e.g., swash vs ocean pipe) and implementing land management decisions. Loading is being estimated for each watershed using the Stormwater Runoff Modeling System (SWARM) model to calculate the runoff volume, and concentrations are applied based on land use characteristics and available data. The loading estimates from the land was validated by comparison to Enterococci, a fecal bacteria indicator, data collected by the state's beach monitoring program in the nearshore of Long Bay.

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THE AMERICAN HORSESHOE CRAB, *LIMULUS POLYPHEMUS*: PHOTOS OF THEIR SURVIVAL AND IMPAIRING LIFE EVENTS

The Horseshoe crab continues to survive. Their cyclic return to the Atlantic coast of North America for spawning has not ceased, but has been impacted by coastal development. For many in the middle Atlantic region, the predictable return of horseshoe crabs is calculated and euphorically celebrated. As a student, citizen scientist and horseshoe crab monitor for two colleges, the thrill of their seasonal returns predominantly during full and new moon high tides in April or May in New York, is also pained by view of their daily challenges by man-made and natural events impairing their life cycle. This photographic essay depicts the field work by scientists and volunteers in New York City and Long Island in an effort to understand and appreciate these phenomena. The projects of Fordham University Professor Mark Botton, New York City Audubon Society, Cornell University Cooperative Extension's Horseshoe Crab Monitoring Program and the Center for Estuarine, Environmental and Coastal Oceans Monitoring of New York City and Long Island Beaches are featured. The importance of coordinated volunteer networks for horseshoe crab research and conservation is emphasized. These photographs are representative of the endless hours by students and volunteers, and are dedicated to the survival and my fascination of this living fossil.

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ADVANCING THE SCIENCE FOR DEVELOPING NUMERIC NUTRIENT CRITERIA FOR ESTUARINE AND COASTAL WATERS

Landscape change and other anthropogenic drivers have led to increased transport of nitrogen (N) and phosphorus (P) through rivers into estuaries and offshore coastal waters. Nutrient pollution and resulting eutrophication commonly degrades water quality, leading to negative effects on aquatic life. Water quality standards, of which water quality criteria are a key component, provide the regulatory framework under the Clean Water Act to protect the nation's waters from N and P pollution and reduce eutrophication. An overview of scientific approaches for deriving numeric nutrient criteria for estuarine and coastal waters will be presented using examples for the estuaries and coastal waters in the State of Florida. Four key aspects are: (1) a science-based approach for delineating the State's waters, (2) identification of relevant, nutrient sensitive, and quantifiable assessment endpoints, (3) development of stressor-response relationships using empirical models and mechanistic simulation models, and (4) development of a reproducible decision process that considers multiple lines of evidence. For coastal waters, satellite remote sensing data can be used for deriving numeric criteria using a reference condition approach. An overview of this method will be included, describing data preparation, validation with field measurements, calculation of numeric criteria, and considerations for translation of future assessments to new satellite missions. Examples provided will relate updated information on the methods and approaches available to adopt numeric criteria to protect the estuaries and coastal waters in their state from nutrient pollution.

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SPATIAL DYNAMICS OF AN OMNIVOROUS FISH ACROSS SUBMERGED AQUATIC VEGETATION SEASCAPES: EXAMINING NICHE BREADTH UNDER DIFFERING FRAGMENTATION LEVELS

Habitat loss and fragmentation can be detrimental to the resilience of marine communities by altering food-web structures and prey-predator interactions. Gut content and isotope analyses have been used to assess food webs and trophic dynamics and depict changes in ecosystem dynamics in response to natural and anthropogenic disturbances. Further, these analyses have been useful for understanding niche shifts of fish species, the importance of habitat size for structuring marine food webs, and discrimination of habitat usage. Little is know about how the niche breadth of marine fish populations responds to the spatial configuration of submerged aquatic vegetation (SAV) patches. This study quantified diet variability as well as changes in the niche breadth of Lagodon rhomboides (Pinfish) in response to spatial structure of SAV seascapes in Biscayne Bay, Florida, USA. This was accomplished by comparing gut content's occurrence and volumetric estimations of prey items as well as the δ13C and δ15N content of muscle tissues of pinsfish collected in continuous and fragmented seascapes (SCS and SFS, respectively). Gut content analysis revealed high similarity in prey items consumed across both SAV seascape types. However, the frequency and biomass of different prey items varied between seascapes. Isotopic δ13C and δ15N signatures were highly variable. Individuals within the SCS tended to be more enriched in δ13C but more depleted in δ15N relative to isotopic signatures from SFS individuals. In general, the total amount of niche space occupied by pinfish was larger in SFS as depicted by the δ13C-δ15N space. Our results demonstrate the critical need to incorporate a "seascape context" into our understanding of the trophic dynamics of key ecological species in order to effectively quantify the effects of coastal management decisions on nearshore SAV communities.

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SEAGRASS PRODUCTION: LINKING INDIVIDUAL, COMMUNITY AND ECOSYSTEM CARBON FLUXES

We tested how individual seagrass traits such as photosynthesis scale to impact high order processes such as community and ecosystem metabolism, using as a model a seagrass meadow of Posidonia oceanica off Stareso, Cosica. On the individual plant leaf level, diel cycles of photosynthesis as a function of irradiance were measured in situ using a multi-channel continuous chlorophyll fluorometer. A model of electron transport rate (ETR) versus irradiance (I) was produced and compared with a model of the response of the P. oceanica net community production (NCP) to light. To develop the NCP/I model, discrete dial cycle measurements of P. oceanica NCP were obtained using benthic incubation chambers. Short duration incubations (2 h) were done to avoid a common problem of this method, the saturation effects within the chambers. The rates of NCP versus I were then compared with O2-optode concentration measurements of the open waters overlaying the seagrass meadow, which were also used for net ecosystem production, NEP, estimates. The diel fluctuations in open-water O2 concentrations were compared with air-water interface CO2 exchange rates, measured with a floating equilibrator chamber. The ETR measured on P. oceanica leaves, were highly correlated with the rates of NCP. NCP, in turn, was highly correlated with the continuous measurements of O2 evolution in the water column, i.e. NEP. No relationships were found between NEP and the air-water CO2 fluxes. Our results suggest that because photosynthesis is a fundamental trait of seagrass meadows, it provides a link between individual- and higher-level processes, such as NCP and NEP. A literature review of photosynthesis and NCP data for seagrasses suggests that the significant relationships between plant photosynthesis and community production can be generalised for many seagrass species. This highlights the keystone role of seagrass species in coastal ecosystems.

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TEMPORAL RESPONSES OF BENTHIC METAZOAN COMMUNITIES IN PERSISTENT HYPOXIC AND HYPERCAPNIC ENVIRONMENTS ALONG SAN DIEGO'S CONTINENTAL MARGIN

Natural gradients of physicochemical water properties and food availability have been shown to limit the depth distributions of sediment communities along continental margins and in the deep-sea. The objective of this research was to identify how benthic meio-, macro-, and megafaunal communities respond seasonally to strong gradients in physicochemical properties through the Oxygen Minimum Zone (OMZ) and Carbon Maximum Zone (CMZ) offshore of San Diego, California. Understanding the sediment community structure in these zones offers insight into how species and taxa have adapted to persistent hypoxic and hypercapnic conditions over evolutionary timescales. The seasonal changes in physicochemical properties (pH, dissolved oxygen, and upwelling signals), and benthic community structure over the San Diego continental shelf and slope were studied in detail over two *San Diego Coastal Expedition* (*SDCE*) cruises in 2012. The *SDCE* was a multidisciplinary, student-led research cruise emphasizing undergraduate and graduate student projects that aimed to expand our knowledge of local continental margin ecosystems by using various geophysical, oceanographic, and ecological techniques. Through the OMZ and CMZ, we observed seasonal differences of depth gradients in dissolved oxygen, pCO_2, pH, and $CaCO_3$ saturation states, which were accompanied by shifts in faunal community composition and biodiversity indices. Above the OMZ, depth-stratified benthic trawls and Remotely Operated Vehicle video transects revealed strong patterns in vertical zonation of megafauna across San Diego's continental margin with calcifying echinoids emerging as the dominant taxon at severely hypoxic sites (~20 μmol kg^{-1}). Our results demonstrate the power of multidisciplinary research in graduate student training to advance our understanding of ocean acidification, shoaling hypoxia, and deoxygenation in the Southern California Bight.

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RESILIENCY OF THE COASTAL RECREATIONAL FOR-HIRE FISHING INDUSTRY TO NATURAL DISASTERS

The financial condition of U.S. Gulf of Mexico recreational-for-hire (RFH) fishing firms post-hurricane damage was examined within the context of the industry's contribution to the resiliency of coastal socio-ecological systems (SES). Three key financial ratios—return-on-assets, assets turnover ratio, and debt-to-assets ratio—were calculated for 2009 from balance sheets and cash flow statements constructed from surveys of 247 RFH firms operating in the five Gulf states. The ratios were then recalculated using reported damage and operational losses from at least one named storm in the 2004–2008 period and combined with the results of a logistic regression model of profitability loss to assess the resiliency of the RFH industry. Results suggest that RFH firm resiliency was a function of operating class (head, charter, and guide boats), homeport, and the way in which the business was structured. Firms appeared to be the most resilient when they employed smaller vessels in intensively managed operations, perhaps due to their ability to move a vessel out of the path of storms and because their profitability and efficiency advantages allowed for self-insurance against losses. As a result, community contributions to, and benefits from, resiliency in the RFH industry may hinge on the development of more modern port facilities and well-functioning insurance markets.

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DEVELOPMENT OF A SEA LEVEL RISE VULNERABILITY ASSESSMENT AND ADAPTATION RECOMMENDATIONS FOR THE STATE OF DELAWARE

Delaware's coastal zone is crucial to the state's economy and location of many of its most valuable natural areas. Tourism is a 2 billion dollar a year industry with much of the revenue coming from beach visitors, eco-tourism, and other water related activities. A major portion of the State's industrial facilities are located on the Delaware River, including a refinery, chemical processing plants and the Port of Wilmington. Two of the oldest cities in the country, New Castle and Lewes, are located on the water's edge. Several other small coastal communities are located along the Delaware Bay. Thousands of acres of agricultural land border tidal wetlands. All these areas will be impacted by sea level rise. The Delaware Coastal Programs was tasked by the Secretary of the Dept. of Natural Resources and Environmental Control to examine the impacts of sea level rise and develop recommendations for adaptation. This process had four distinct phases; development of sea level rise scenarios to be used for assessment and planning; creation of GIS layers and other maps to show the extent of inundation; convening of a stakeholder advisory group to determine resources at risk and impacts from SLR in three categories (Natural Resources, Public Safety and Infrastructure, Social and Economic); and development of recommendations for adaptation. The vulnerability assessment and adaptation recommendations were crafted through an open process that involved numerous and divergent stakeholders groups, resource experts, several public meetings and presentations. Two documents were created, a 2-volume Vulnerability Assessment that contains 86 maps showing the affected resources, and an Adaptation Recommendations document with 62 recommendations of varying scope, designed for homeowners, businesses, local governments and state agencies. This presentation will outline the process involved to develop the documents, pitfalls and successes, and the beginning stages of adaptation implementation.

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THE ROLE OF SCIENCE IN PORTS, BEACH NOURISHMENT, AND ECOSYSTEM RESTORATION IN COASTAL AND ESTUARINE SYSTEMS

Whether it is the deepening or expansion of a port, the re-nourishment of a beach or an ecosystem restoration project, the U.S. Army Corps of Engineers (USACE) utilizes information that many estuarine researchers have collected and analyzed in planning and executing projects. Ports throughout the world are looking to expand (deepen and widen channels) to accommodate the larger ships (post-Panamax) that are expected when the wider and longer locks at the Panama Canal are completed in 2015. Although many large container ports on the Pacific Coast of North America are post-Panamax ready, most of the ports on the Atlantic and Gulf Coast, many of which are in estuaries, are currently expanding/modernizing or are planning to do so. Environmental mitigation issues include, but are not limited to, benthic recovery after dredging and disposal, disposal of contaminated sediments, incidental take of imperiled species, impacts from blasting, and saltwater intrusion into freshwater ecosystems, aquifers and water supplies. On a positive note, the beneficial use of dredged materials is being examined in many port expansions. Beach re-nourishment, also known as hurricane and storm damage reduction, became a highly publicized activity in the wake of Superstorm Sandy. Issues encountered with beach nourishment include sand movement post nourishment and how intertidal ecosystems, from rocky bottoms to sea grasses and kelp, will be affected. Ecosystem restoration projects continue to be developed by the USACE and its non-federal sponsors in high profile ecosystems such as the Everglades and Chesapeake Bay as well as many other estuarine ecosystems. Information from researchers often plays a key role in understanding problems and opportunities in the area to be restored as well as the successes and failures of other ecosystem restoration projects. Scientific information and research is utilized in the planning and execution of port, re-nourishment and ecosystem restoration projects.

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INVASIVE MANGROVES IN TEXAS: SURVEYS AND HIGH RESOLUTION IMAGERY TO MAP DISTRIBUTION, CANOPY HEIGHT AND COVER, AND RESPONSE TO A SEVERE FREEZE

In 2008, high resolution (1 m, 67 bands) AISA Eagle imagery was obtained for Redfish Bay, in the Mission-Aransas National Estuarine Research Reserve on the Coastal Bend of Texas. The imagery was used, in part, to map the spatial and size distributions of invasive Black Mangrove. In our study area, mangroves have displaced greater than 90% of the salt marsh cover in recent decades, and occupy about 640 hectares (6.4 million imagery pixels). An algorithm to predict mangrove canopy height, developed from 2008 field survey data regressed against vegetation index values from respective flight-line pixels, was applied to the 2008 AISA imagery. Most plants were relatively small, with a median canopy height of about 79 cm. We detected a gradient of freeze damage following two hard freezes in February, 2011, with nearly total above-ground dieback nearest the mainland and areas of intermediate and minimal damage extending across the bay to the barrier islands. Field surveys one month after the freeze found no canopy cover at high damage sites, versus canopy covers of about 59% and 16% of pre-freeze values at intermediate and low damage sites. We documented rapid above-ground recovery in visits 8 months and 23 months after the freeze. By January, 2013 canopy cover was 67% and 78% of pre-freeze values, and canopy height was 62% and 76% of pre-freeze values at high and intermediate damage sites. We recently obtained and are currently analyzing two WorldView 2 satellite scenes (2 m, 8 band resolution) acquired 10 months and 23 months after the freeze, and are using vegetation indices to further document and quantify the damage gradient and recovery rates across our study area.

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BLACK MANGROVE EXPANSION INTO SALT MARSHES OF THE NORTHERN GULF OF MEXICO: WILL CLIMATE CHANGE RESULT IN SIGNIFICANT ECOSYSTEM LEVEL CHANGES?

A prime example of climate-induced range shifts is the expansion of the tropically associated black mangrove (Avicennia germinans) into the northern Gulf of Mexico. This tropically associated species has invaded temperate systems dominated by saltmarsh cordgrass (Spartina alterniflora) and black needlerush (Juncus roemerianus) in southern Louisiana and most recently on Horn Island, MS, in the Gulf Islands National Seashore (GUIS). Because salt marshes are critical nursery habitats for a variety of ecologically important finfish and shellfish, the introduction of black mangroves may have significant consequences on their composition and abundance. To date, little is known about the role black mangroves may play as nursery habitats for juvenile finfish and shellfish or whether they are comparable to salt marshes. The main objective of this study is to quantify and compare fish and macrofaunal use in Spartina-dominated; black mangrove-dominated; and mixed Spartina and black mangrove habitats. Suction sample and infaunal collections were conducted every month from April to October 2012 to estimate finfish, shellfish, and infaunal abundances and diversity among the three habitats. Preliminary results show that there are significant differences among Xanthid crabs with the greatest abundances found in the mangrove habitat ($p<0.001$). In addition, there was a significant difference in community composition between the black mangrove and the mixed mangrove and salt marsh habitats being driven mainly by Tanaids ($p=0.017$). Future efforts including fyke net surveys and habitat preference experiments will provide us with the information we need to determine how mangroves are influencing these communities. Overall, a lack of any clear negative impact of the expanding black mangrove on finfish and shellfish indicates that these habitats may play a similar nursery role for finfish and shellfish species.

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NOVEL FEEDING BEHAVIOR IN AN INTRODUCED AMPHIPOD: A BICOASTAL COMPARISON

Native to the Atlantic North American coast, Ampithoe valida is a gammarid amphipod that is presumed introduced along the Pacific coasts of the U.S., including San Francisco Bay. Observed feeding behavior of A. valida in San Francisco Bay shows regular consumption of both vegetative and flowering eelgrass shoots and damage to eelgrass meadows, potentially reducing eelgrass fitness. This feeding behavior has not been observed in its native range where this amphipod primarily grazes on micro- and macroalgae, including Ulva and Gracilaria. The mechanism(s) as to why feeding preference for eelgrass differs between regionally distinct populations of A. valida is uncertain. In a series of multiple choice feeding assays with fresh eelgrass tissue as well as macroalgae, San Francisco A. valida consumed eelgrass even when Gracilaria verrucosa, a known desirable food, was provided. Food choice assays using both fresh and freeze-dried eelgrass tissues show a preference of local amphipods for San Francisco Bay eelgrass tissues over two other California eelgrass populations (Bodega Bay, Tomales Bay) and another eelgrass population from A. valida's native range (York River, Virginia). Carbon to nitrogen ratio analyses between eelgrass populations did not explain differences in feeding preferences. Additional pair-wise assays using both San Francisco Bay and Virginia A. valida will permit further evaluation of the role of plant physical structure on grazer preferences (freeze-dried vs. fresh). Additional assays will pursue whether feeding patterns of A. valida populations in its native range mirror the results found using the putatively introduced California A. valida. Identifying and understanding the factors controlling herbivory by A. valida will help inform eelgrass restoration efforts and effective habitat management.

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MANAGING THE SUSTAINABLE USE OF EUROPEAN MARINE ECOSYSTEM SERVICES: THE ECOSYSTEM APPROACH

Management of marine ecosystem services has met with limited success because of a sector by sector approach, failure to recognise the importance of marine ecosystems and in governance. The Ecosystem Approach (EA) which underpins recent European legislation (Marine Strategy Framework Directive, MSFD) and transnational agreements (OPSAR Convention) is based on the holistic assessment of human pressures and sustainable use of marine ecosystem services. Implementing the EA represents a key challenge to scientists and policy makers. Ecologically meaningful targets and indicators/standards (to maintain ecosystem structure and functioning) need to be integrated with current and emerging management practices. Consideration of ecosystem state is not currently used in European fisheries management. However, the European Commission has identified Maximum Sustainable Yield (MSY) as a key element of the future Common Fisheries Policy and future advice from ICES will integrate MSY with the precautionary principle and the EA. The establishment of an ecologically coherent network of Marine Protected Areas (MPAs) is explicit in the MSFD and an obligation under OSPAR which has also established reference points for some non-target species. In this paper, we consider some of the challenges in developing strategies for the sustainable use of ecosystem services and meeting the legislative requirements for environmental protection (e.g. Good Environmental Status for the MSFD). The EA is often highlighted in fisheries management but we suggest there is a need to ensure that fisheries management is part of a holistic approach to managing human use of ecosystem services. To support the implementation of the EA, coastal waters and shelf seas should be assessed to: determine their current ecological state; quantify the probability of future change in state; determine the economic consequences of any future change in ecosystem state on the sustainable use of ecosystem services.

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FORTNIGHTLY VARIABILITY OF HYDROGRAPHY AND EXCHANGE FLOWS IN A TROPICAL SEMIARID ESTUARY DURING DRY AND WET SEASONS

The Mossoró estuary is among two dozen estuaries along the northern coast of Brazil in the states of Ceará and Rio Grande do Norte. All of these estuaries are <40 km long and <5 m deep on average. They are in a semi-arid climate with well distinguished wet (Feb-May) and dry (Aug-Nov) seasons. During the dry season most estuaries receive no fresh water inflow and become hypersaline. The main objective of this study was to investigate the hydrodynamics of Mossoró estuary under the two contrasting hydrological conditions. Two field campaigns were carried out in October 2012 (dry period) and May 2013 (wet period), when moored, station and underway profile data were acquired. The estuary showed hypersalinity in the dry season, when salinity increased landward, starting with 37 at the mouth and reaching a maximum of 70 at 20 km from the mouth. In the wet season, the salinity distribution was 'classical' starting with 37 at the mouth and decreasing landward

at an average rate of -0.8 km-1. The wet period was dominated by gravitational circulation with a marked river influence during both spring and neap tides. The dry period was influenced by residual seaward flow over the whole water column in spring tide. Seaward flows shifted to residual landward flows at intermediate tide, and changed to an unexpected classical gravitational circulation (outflow at surface and inflow at depth) during neap tide. Discussions will center on this complex and puzzling circulation structure during the dry season.

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BRIDGING THE GAP BETWEEN SCIENCE AND MANAGEMENT IN CALIFORNIA

California is a hugely diverse state, both ecologically and politically. This presentation explores three examples of how science was utilized to inform and shape management in three California ecosystems. The first example illustrates the development of estuarine sediment quality objectives, a regulatory tool used to assess and limit sediment contamination. Managers, stymied by uncertainty, adopted a multiple line of evidence approach in order to utilize the best information from sediment chemistry, sediment toxicity, and benthic infauna. The second example established "natural" water quality limits in Areas of Special Biological Significance, a type of coastal Marine Protected Area. Science was used to help translate narrative regulatory guidance into numerical objectives. The key to the science behind this translation included interpreting what managers considered "natural" and then collecting one-of-a-kind reference data for nearshore ocean waters following storm events. The third example balanced the need for statewide consistency with site-specific applicability to set biocriteria in California's diverse stream network. This balance is an especially challenging task considering California stream biodiversity includes the highest (Mt Whitney) and the lowest (Death Valley) elevations in the contiguous United States. By examining how scientists interacted with managers to achieve positive outcomes in these three case studies, we can decipher valuable lessons on how to bridge their perceived gap.

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CARBON STORAGE IN COASTAL ECOSYSTEMS OF ABU DHABI, UNITED ARAB EMIRATES

Understanding carbon dynamics in ecosystems is increasingly important in light of accelerated climate change. Recently, the high rates of coastal ecosystem carbon sequestration have become apparent, stimulating global attention towards better management and restoration for climate change mitigation. Few data exist for hyperarid-hypersaline coastal wetlands of the Arabian Gulf. As part of the Abu Dhabi Blue Carbon Demonstration Project, facilitated by the Abu Dhabi Environmental Data Initiative (AGEDI), with support by Environment Agency – Abu Dhabi (EAD) and led by GRID-Arendal, we quantified carbon pools of mangroves, salt marshes, algal flats, and sabkha. *Avicennia marina* and *Arthrocnemon macrostachyum* dominate mangroves and salt marshes, respectively. In January 2013 we quantified the carbon stocks of 8 natural mangrove stands, 7 mangrove plantations (aged 2 to 17 years), 5 salt marshes, 4 algal flats, and 5 sabkhas. Soil organic and inorganic carbon and bulk density were calculated. Soil bulk density tended to be lowest within the top 15cm of the soil suggesting higher organic matter concentration. Mangroves had the lowest bulk density (0.73 g/cm^3), followed by algal flats (0.96 g/cm^3); values across other ecosystems were comparable (1.20 – 1.38 g/cm^3). Soil carbon pools were dominated by inorganic carbon in the form of carbonate. Soil organic carbon was highest in the mangroves and algal flats, followed by salt marshes and sabkha, with large pools corresponding to long periods of inundation. Mangrove above-ground biomass greatly varied by location (9-189 Mg/ha; 66 Mg/ha mean) as did salt marsh biomass (2.7-9.4 Mg/ha; 4.9 Mg/ha mean). Biomass of planted mangroves increased with age but was lower in mass than natural stands. Coastal ecosystems in Abu Dhabi are sequestering carbon, although on the low end of carbon sequestration rates internationally, which highlights their importance as carbon reserves relative to other vegetated ecosystems of the Arabian Gulf.

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MODELING POTENTIAL HABITAT FOR CHESAPEAKE BAY LIVING RESOURCES

Climate change and other anthropogenic perturbations are altering and reshaping the Chesapeake Bay along with the biological communities that comprise it. This study quantifies changes in the volume of potential habitat for a suite of commercially and economically important species based on temperature, salinity, and dissolved oxygen. Ten years of output from a coupled 3D hydrodynamic and biogeochemistry model for the Chesapeake Bay was incorporated into a habitat volume model (HabVol) to estimate daily volumes of habitat defined by a species' physiological tolerances. The required habitat (constrained by mortality) and optimal habitat (related to areas of highest growth) was calculated for twelve species including multiple life stages of striped bass, blue crab, Atlantic sturgeon, bay anchovy, eastern oyster, and bluefish. Reductions in required habitat due to temperature, salinity, and dissolved oxygen limitation ranged from 0% to 40%. Salinity was the primary constraint on required habitat for most species, with egg and larval lifestages showing the highest sensitivities. Reductions in optimal habitat ranged from 0% to 95%, with temperature playing a much larger role in habitat limitation. Predictable relationships between physiological tolerances and changes in habitat volumes were identified. Results show that habitat volume is a potentially useful indicator of environmental and ecosystem-related change. Due to the synthesis of complex spatial data, habitat volume estimates could be used as habitat mediation functions in models like Ecopath and Ecosim that explicitly incorporate trophic dependencies.

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IS THERE A CHARACTERISTIC ANTHROPOGENIC δ^{15}N SIGNAL TO NARRAGANSETT BAY, RI?

Often stable isotopes are used as a tracer of nutrient-N sources to estuaries and it is assumed that anthropogenic sources have enriched N isotopic compositions. This is based largely on analysis of the N composition of particulate matter. Here we characterize source nitrate isotopic composition variability with samples from anthropogenic sources to Narragansett Bay, rivers and wastewater treatment facilities (WWTFs) collected in 2009 and 2012. Sampling occurred before, during, and after upgrades to tertiary treatment by local WWTFs in an attempt to assess the impact of the upgrades on the isotopic inputs. Samples were analyzed for nitrate concentration, stable N (δ^{15}N) and stable O (δ^{18}O) isotopic compositions of nitrate. WWTF δ^{15}N values ranged from -4 to +21‰, and -7 to +28‰, and δ^{18}O from -16-6‰, and -1-30‰ (2009, 2012). Riverine δ^{15}N values ranged from +4 to +12‰, and +7 to +20‰ and δ^{18}O from -2 to +12‰, and -10 to +10‰ (2009, 2012). The data were flux corrected using discharge rates and nitrate concentrations. Flux-corrected δ^{15}N for all anthropogenic sources ranged from +5 to +15 ‰, and δ^{18}O ranged from -2 to +8 ‰. 2009 annual average δ^{15}N for WWTFs and rivers were +7 and +9 ‰, while 2012 were +14 and +13 ‰, respectively. Annual average δ^{18}O for WWTFs and rivers were -2 and +1 ‰, and +7 and +5 ‰, respectively for 2009 and 2012. During the summer and early fall, anthropogenic δ^{15}N peaked at a time when river and WWTF discharges were low. On average, tertiary treatment increased WWTF effluent δ^{15}N and δ^{18}O by ~18‰ (flux-corrected; $p<0.005$), and increased δ^{15}N and δ^{18}O of most rivers by 5‰ and 4‰, respectively (flux-corrected; $p<0.01$). Overall, nitrogen inputs decreased, and isotopic composition of nitrate increased to levels higher than those at the onset of tertiary treatment.

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INVESTIGATING RARITY IN AN ENDEMIC WETLAND THISTLE

The highly urbanized San Francisco Estuary contains 90% of California's remaining coastal wetlands, as well as high concentrations of invasive and rare species. One narrow endemic taxa, the Federally-listed Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*), is restricted to two populations in which the invasive perennial pepperweed (*Lepidium latifolium*) has an increasing presence. In this study, we investigated two factors that may further contribute to rarity in the Suisun thistle. To examine impacts of pepperweed, we conducted a removal experiment and surveyed soil-plant relationships. To identify intrinsic life history constraints, we quantified seed set, predation, dispersal, and germination. We found evidence suggesting that pepperweed negatively affects the Suisun thistle via competition for space, nutrients, and light, alteration of soil physicochemical characteristics, and interference with reproductive success. Intrinsic limitations include low seed set, high seed predation by beetle larvae, low localized wind dispersal of seeds, and possible inbreeding in smaller subpopulations. Results from this study will inform management of existing Suisun thistle populations, as well as guide restoration plans for Suisun Marsh.

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DROUGHT AND LOW INFLOW CONDITIONS IN TEXAS ESTUARIES: OBSERVATIONS FROM THE RECORD-BREAKING DROUGHT OF 2011

Water planning in Texas is based in large part on evaluating water resource availability during periods when climatic conditions induce either low-flow or drought of record

situations. During such periods, river flows are reduced, and therefore freshwater inflow to the estuaries also is reduced leading to elevated salinities and to reductions in sediment and nutrient loads. Aside from a few isolated studies covering the response of Texas bays to drought during the 1950's, the effects of low-flow and drought conditions on the productivity and health of Texas' estuaries is poorly understood. Recent legislative efforts to address freshwater inflow needs of estuaries recognize the importance of determining an appropriate inflow regime which is consistent with natural variability in freshwater inflow. Thus, it is necessary to understand the role of low inflows to estuarine ecosystems. This study provides an overview of the documented impacts of low inflow conditions on Texas estuaries with emphasis on the extreme drought of 2011 and consideration of the historical drought of record during the 1950's. Coast-wide, average annual inflow was estimated to be 38.6 million acre-feet for a period of record from 1941 – 2011. During the drought of 2011, average annual inflow was estimated to be 6.4 million acre-feet, an amount less than a quarter of typical freshwater inflow. In all estuaries, monthly mean salinity increased substantially and many new records of maximum salinity values were set. In less extreme years, identifying drought can be difficult; therefore, different approaches for identifying drought condition in estuaries will be evaluated. Ultimately, this study will guide further analyses of low-inflow effects on estuarine ecosystems. This is especially important as the State of Texas faces increasing demands for freshwater resources which have the potential to induce drought-like inflows at intervals more frequent than experienced by natural droughts.

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CHANGING SANDY BEACH ECOSYSTEMS IN CALIFORNIA: COMPARISONS OF INTERTIDAL BIODIVERSITY THREE DECADES APART

Measuring changes in biodiversity is central to evaluating anthropogenic and climatic impacts on ecosystems. We compared species richness and composition of intertidal macroinvertebrate communities of sandy beaches from surveys in the 1970s to surveys >30 years later at 13 beaches, including five MPA baseline sites, in central and southern California, USA. Observed species richness varied over five-fold among beaches in both study periods (1970s: x = 25 ± 4, range = 8–46 species; 2009– 2011: x = 28 ± 4, range = 8–52 species). For the majority of beaches, changes in richness were consistent in magnitude and direction for both observed and adjusted (for sampling area by rarefaction) estimates of richness. Values of adjusted richness differed significantly (95% CI) between survey periods at seven of the 13 beaches and were lower at six beaches (23%–109%) and higher at one beach (54%) in the 1970s. At four beaches, substantial increases in adjusted richness (12 to 27 species) since the 1970s suggested the community recovered from earlier impacts. Wrack-associated species made up the majority of the change in observed species richness at eight of the 13 beaches including all sites where significant change was detected except one continuously groomed beach. Our analyses demonstrate that change in intertidal species richness over three decades was not uniform in direction or magnitude suggesting that beaches have responded to local-scale processes rather than regional change. Our results indicate that beach ecosystems are highly sensitive to anthropogenic impacts, especially low dispersal wrack-associated species. However, given sufficient time following impacts, such as off-road vehicle use, recovery of these important coastal ecosystems is possible.

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TWO PAR SENSORS USED TO MEASURE LIGHT ATTENUATION WERE NOT CREATED EQUAL

The depth of light penetration has large ramifications in estuaries and coastal systems as it determines the amount of photosynthetically active radiation (PAR) available to phytoplankton and benthic primary producers. Scientists use the diffuse vertical attenuation coefficient for downwelling PAR, KPAR, for many purposes such as computation of photic-zone depth and primary production or as an index of habitat quality. Our purpose is to remind ecologists that KPAR can differ when derived from planar (cosine) versus scalar (4pi, spherical) sensors. Both sensors are commonly used, often interchangeably, but were designed to measure different radiometric quantities. We collected over 1200 paired depth profiles of PAR from planar and scalar sensors in San Francisco Bay. Results from 2006-8 have previously been presented; this presentation includes new results from 2010 measurements and modeling. KPAR from the scalar sensor was up to 40% lower than the planar sensor. We calculated daily phytoplankton gross primary production (GPP) using a biomass-depth-light model that included KPAR plus concurrent in-situ chlorophyll and surface PAR. Using scalar KPAR in the calculation overestimated GPP from planar KPAR, by up to 76%, and the error is compounded when calculating annual GPP. In 2010 we measured total scattering, backscatter, and colored dissolved organic matter to better calibrate Hydrolight model runs to the San Francisco Bay light field. The model was used to test sensitivity to influencing parameters and revealed that episodes of elevated turbidity and/or phytoplankton biomass produced the greatest divergence between sensors. The impact of sensor choice is especially significant when considering trends in long term data sets, comparisons between different systems, and accuracies in models.

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SENSITIVITY OF SALINITY INTRUSION TO CHANNEL DEEPENING

The sensitivity of the residual salinity distribution to channel deepening is investigated within the framework of a 2DV (i.e. cross-sectionally averaged) model of a tidally dominated, vertically well mixed estuarium with freshwater input on the landward side. Using a state-of-the-art numerical model (GETM) in an idealised geometrical setting, it is found that there is a critical depth for which the salinity distribution is moved considerably towards the landward side. The mechanism resulting in this sudden shift is investigated using an idealised model. In this model, the vertical mixing profile depends on depth parabolically and accounts for time dependent mixing by two effects: (a) variation of vertical mixing length as a result of the vertical tide and (b) density stratification. The latter is modeled by the Munk Anderson (1948) formulation. It is demonstrated explicitly that the residual advection of salinity by advection with the dominant M2 tidal flow accounts for a landward salinity flux which (together with diffusive transport) balances the freshwater flux from the landward boundary, and the changes in this balance are discussed in detail.

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ASSESSING MACRO-INVERTEBRATE ABUNDANCE AND ASSEMBLAGE STRUCTURE IN TIDAL WETLANDS: IMPLICATIONS FOR RESTORATION SUCCESS

Macro-invertebrate communities are a critical component of tidal wetlands and constitute an important measure of the success of coastal wetland restoration. We compared infaunal and epifaunal macro-invertebrate assemblages between constructed tidal creek and main channel habitats in San Dieguito Lagoon (SDL), site of a recent restoration project, and compared these assemblages to those in similar habitats in three reference wetlands spanning the Southern California Bight (Carpinteria Salt Marsh, Mugu Lagoon, Tijuana Estuary). Density and species richness were estimated from all four wetlands in summer of 2012. Total invertebrate density was lower in both habitats in SDL than in the reference wetlands. Species richness in SDL was comparable to the reference wetlands in main channels, but much lower in tidal creeks than in the reference wetlands. Multivariate analyses indicated clear differences in assemblage structure between SDL and the reference wetlands as well as differences between tidal creek and main channel habitats in SDL but not in the reference wetlands. SIMPER analysis revealed that the lower abundance of small crustaceans (amphipods, tanaidaceans) in the creeks largely accounted for this difference. Factors contributing to the observed patterns in invertebrate density, richness, and assemblage structure in constructed tidal creeks and main channels in SDL may include differences in tidal elevation and sediment properties (e.g., organic matter content, grain size) between these habitats.

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THE HULL NINE YARDS: A COMPLETE LOOK AT BIOFOULING MANAGEMENT, HULL HUSBANDRY PRACTICES, AND VOYAGE CHARACTERISTICS OF VESSELS OPERATING IN CALIFORNIA

Commercial shipping is the primary pathway for the introduction of nonindigenous species (NIS) into coastal environments in California, North America, and across the globe. These shipping-mediated introductions occur primarily through two mechanisms, ballast water discharge and vessel biofouling (i.e. the attachment or association of organisms to a vessel's wetted surfaces). Vessel biofouling is believed to be responsible for up to 60% of the 257 nonindigenous species currently established in California's coastal waters. Most vessel operators manage biofouling on the hulls because of its impact on a vessel's drag, fuel consumption, and operating costs. However, biofouling associated with a vessel's remaining underwater surfaces, including "niche areas" (e.g. bilge keels and sea chests) that are more susceptible to biofouling because of variable hydrodynamic flow or inadequate antifouling protection, are often undermanaged and may pose a greater risk of species introduction. In an effort to better understand the current biofouling management practices of the vessels that operate in California, the State Lands Commission's Marine Invasive Species Program (MISP) has been collecting annual hull husbandry and voyage data from each vessel operating in state waters since 2008. These data have highlighted specific differences in biofouling management strategies and voyage patterns among different types of vessels. For example, container vessels and auto carriers are more likely than bulk carriers to have dedicated marine growth prevention systems to protect against biofouling accumulation in sea chests and internal piping networks. These patterns of biofouling management strategies and their influence on the potential risk of NIS introductions are informing the ongoing development of management regulations to reduce the likelihood of biofouling-mediated NIS introductions to the state of California.

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THE BIO-AMPLIFICATION OF THE PHOSPHORUS CYCLING IN THE SEDIMENTS OF A LAGOONAL ESTUARY: IMPLICATIONS FOR EUTROPHICATION AND CYANOBACTERIAL BLOOMS

Phosphorus (P) is known as a critical driver of diazotrophic cyanobacterial blooms in estuarine systems, as sediments are often found to recycle P more efficiently than nitrogen (N), resulting in lower N:P ratios within the overlying water column. In addition, macrofaunal burrows are known to influence the flux of solutes between the sediment and overlying water and can increase nutrient recycling rates. This internal recycling of P is likely to be the major source of P entering the water column, particularly during summer months when blooms occur. We investigated the impact of the polychaete *Capitella capitata* on the biogeochemical cycling of P and iron (Fe) in the estuarine Gippsland Lakes (Australia). Intact sediment cores were sampled from a central site in the Gippsland Lakes under anoxic water column conditions and subjected to a series laboratory experiments to quantify the interaction between Fe and P cycling. Planar optode measurements of the intact sediment cores coupled with sediment extraction analysis of the field samples and laboratory core incubations clearly identified the role of *C. capitata* in P cycling and showed that: 1) the internal stores of bioavailable P associated with easily reducible iron-oxyhydroxides extended deep into the sediment (20 cm) and were released during sediment anoxia leading to very high fluxes of P during the bloom period; and 2) upon re-oxidation of the bottom waters there was a regeneration of easily reducible Fe deep within the anoxic zone of the sediment (20 cm). This process was mediated by *C. capitata* which controlled the supply of oxygenated water deep into the anoxic zone of the sediment via its burrows, leading to the re-oxidation of Fe and associated binding of P. These results suggest that through bioirrigation, *C. capitata* acts as a 'biogeochemical amplifier' increasing both the uptake and release of P and Fe from the sediment as redox conditions change.

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OCCURRENCE AND IMPACTS OF COASTAL HYPOXIA IN TROPICAL OLIGOTROPHIC ISLAND SYSTEMS: EUTROPHICATION RISK BASED ON WATER QUALITY AND MARINE PLANT ASSEMBLAGES ON BAHAMIAN REEFS

A multi-year assessment of eutrophication risk to near shore reefal environments across the Bahamian archipelago documented water quality parameters over daily, tidal and seasonal cycles. The Bahamas are known for very clear oligotrophic waters, and thresholds of nutrient loading are difficult to document at very low nutrient concentrations.. This study addressed two questions,: 1.) What patterns and trends in hypoxic events and eutrophication are seen throughout the islands of The Bahamas?, and 2.) What impact are these hypoxic events having on the marine plant species assemblages on coral reef habitats, and are there marine plant species indicative of eutrophication? Marine plants (seagrasses and benthic algae) can reflect water column nutrient conditions, and are vulnerable to coastal eutrophication. Water quality surveys were carried on 6 different islands, each island surveyed over an 18 -month periods, and 27 sites surveyed over multiple (> 3) years. Water Quality surveys aimed to document the occurrence of coastal hypoxia by documenting dissolved oxygen and turbidity over daily, tidal and season cycles. Marine plants were surveyed on near shore hard bottom, patch reefs and offshore reefs using a checklist of conspicuous species for presence / absence, and point-intercept for coverage of abundant species. The results show widespread hypoxic events throughout the archipelago, even on islands with low human populations. Eutrophication thresholds for each island system are unique: differing with geomorphology, oceanography and ecology. However, there are sufficient indicators of both water quality and benthic algal species assemblages that can be used to map eutrophication events.

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ASSESSING THE IMPACT OF WATERSHED DEVELOPMENT AND RESTORATION ON LAND-BASED (TERRIGENOUS) SEDIMENTATION IN COASTAL BAYS WITH CORAL REEFS IN ST. JOHN, US VIRGIN ISLANDS

In the US Virgin Islands (USVI), development and the building of dirt roads has increased the delivery of land-based (terrigenous) sediment to bays with coral reefs. In 2011, community and federal environmental managers installed watershed restoration projects in the USVI to mitigate the negative impacts of sedimentation on corals. In order to examine the factors that affect spatial and temporal variation in terrigenous sedimentation and ultimately the effectiveness of these restoration projects, we monitored marine terrigenous sedimentation using sediment traps over five rainy seasons (2008-12) below two developed/ restored and three undeveloped watersheds in eastern St. John. Trap accumulation rates were measured at nine shore and five reef sites during 50 26-day sampling periods (19 post-restoration). Terrigenous sedimentation rates (mg/cm^2/day) were calculated by multiplying the total sedimentation rate by the % terrigenous fraction (determined by loss on ignition [LOI]). Over the time series, there were consistently higher rates of terrigenous sedimentation (5 to 15 times on average) below developed watersheds than below undeveloped watersheds. Though peaks in terrigenous sedimentation were associated with periods of high rainfall during major storms, there was not a significant correlation between rainfall and terrigenous sedimentation during periods of low-moderate rainfall. Due to minimal runoff-producing storms following completion of watershed restoration projects, we cannot yet test whether there has been a reduction in marine terrigenous sedimentation post-restoration. Our analyses suggest that factors affecting marine terrigenous sedimentation are complex and approaches for monitoring watershed restoration should include: a longer post-mitigation monitoring period; integrated monitoring of turbidity, stream runoff, and oceanographic energy (waves and currents); and marine sedimentation data on temporal scales consistent with runoff events (hours-days).

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INFLUENCE OF RECRUITMENT ON ATLANTIC BLUEFIN TUNA STOCK MIXING WITHIN US FISHERIES, 1976-2012

Migrations within populations of Atlantic bluefin tuna originating from either the Mediterranean Sea or Gulf of Mexico cause some individuals to co-occur in the same region, resulting in mixed stock fisheries and necessitating coordinated international management.

Here, the proportional contribution between populations in fishing areas is an emergent property: dependent upon population-specific production (recruitment) and movement rates. We used otolith stable isotope differences associated with the nurseries of the two principal populations to examine mixing levels for bluefin tuna over a multi-decadal period during which the populations varied in abundance. Spawners caught from Gulf of Mexico fisheries during 1978-2012 showed strong natal homing (100.0%±0.01 SD %) regardless of sampling period. In contrast, US fisheries that select school sized bluefin tuna (70-150 cm CFL) have shown a cycle in mixing levels during the past four decades. A small sample of school-sized bluefin was dominated by Gulf of Mexico members in 1976-1977 (100.0%±0.1%; N=26), then two decades later (1997-2000) this contribution was diminished (54.3%±4.9; N=120), but another decade later (2011-2012) mixing level was again dominated by Gulf of Mexico members (100% ±0.1%; N=247). This cycle of mixing may have been influenced by relative recruitment rates between the two populations. To evaluate this further, a recent strong year-class (2003), apparent in the North Carolina winter fishery, was compared with other year-classes. According with expectation, the 2003 year-class showed a higher Gulf of Mexico contribution (98.3% ± 3.6% SD) than other year-classes (73.6% ± 5.6%). Resolving the interplay of movement rates and production on mixing dynamics in Atlantic bluefin tuna will require population-specific estimates of recruitment, mortality, growth, and movements, which are best integrated and simulated in stochastic catch-at-age models.

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LESSONS LEARNED IN HORSESHOE CRAB CONSERVATION IN JAPAN - CAN THEY HELP PREVENT ITS EXTINCTION IN ASIA?

Horseshoe Crabs (HSC) in Japan (Tachypleus tridentatus) were designated an endangered species in the 1990s. HSC habitat shrank to the western edge of its original extent, and is presently limited to northern Kyushu. A review of its conservation history over more than a century shows experiences and lessons learned in various fields, and reveals how modernization and economic growth impact coastal ecosystems, how long-term measures can be sustainable, and how multi-sectoral collaboration is essential. We drove HSC to the edge, but some HSC habitat has recently been recovered. However, other Asian countries are rapidly creating more HSC survival crises, meaning that lessons learned in Japan are not being sufficiently utilized. (1)Changes in disciplines driving conservation The focus has recently shifted from biological measures like larval releases towards habitat conservation. This shift was made possible by changes in social and legal structures relating to environmental policies for water and land management. (2) Changes in perceptions of HSC habitat Targets of studies and measures have expanded from points of spawning spots to lines connecting sandy beaches to tidal mud flats. Furthermore, management approaches have expanded from lines to planes that encompass entire spawning coasts. (3)Consensus building with fisheries Consensus building to promote both effective nature conservation and human use is usually very hard. Fishery industries relying on wild species are now pursuing sustainability and using ecosystem-based management. HSC has become the symbol of a healthy coastal zone. (4) Discovering the importance of buffer zones and sustainability If habitats for all stages of HSC life history are conserved, coastal disasters may be ameliorated. HSC habitats are important buffer zones. Thus, as we reconsider coastal matters in the wake of tsunami damage, HSC habitat conservation can symbolize integrated coastal management, especially land use.

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SUCCESSFUL MENTORING OF DIVERSE STUDENTS IN A WELL-ESTABLISHED REU PROGRAM

The Virginia Institute of Marine Science's NSF-funded Research Experience for Undergraduates site program began in 1989. Each year, we select mentors from our faculty who have interests and expertise aligned with the interests of the top student applicants to our summer program. We actively recruit highly qualified students from underrepresented groups, seek students who are well prepared academically, but also actively seek diversity in perspective and background. As a result, we have had students of diverse racial and ethnic backgrounds, from dissimilar colleges and universities, and with a variety of outside interests and talents. Thirty-nine percent of the interns in the program 1997-2010 were African American, Hispanic, Latino, Native American, or Asian, and 74% were female. Our alumni tell us that this diversity adds value to their experiences in the program. We provide research opportunities focused on coastal marine and estuarine science to enhance the participation of groups underrepresented in the ocean sciences, and we have several group activities and field trips for interns during the summer that enhance their experience. Faculty mentors, along with graduate students, work one-on-one with the interns to guide them through development, execution, and presentation of research projects. The success of our program is evident in that most of our alumni have gone on to careers in science or are seeking advanced degrees in science. Many have entered the fields of ocean science, another geoscience, or a closely allied field. The majority of these interns (73% of under-represented, 85% of well-represented) pursued careers in science or engineering or are obtaining advanced degrees in those fields. Relative to well-represented alumni, under-represented alumni had more diverse career paths (e.g., law or medical fields).

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ANTHROPOGENIC STRESSORS AFFECT BENTHIC COMMUNITY STRUCTURE: UPLAND USAGE AND SHORELINE DEVELOPMENT

Anthropogenic stressors can affect communities within the land-water interface. Upland development, increasing shoreline hardening, and other anthropogenic effects threaten the economically and ecologically important species that use these habitats. In this study, we examined the consequences of anthropogenic stressors on benthic communities in 12 subestuaries of Chesapeake Bay. We investigated how subestuary upland usage (i.e., forest, agricultural, developed) and shoreline development (rip-rap and bulkhead compared to marsh and beach) affected density and diversity of benthic infauna. Density of infauna was significantly affected by upland usage, with lowest density in areas with heavy upland development and highest density associated with high percentages of wetland in the subestuary. For large macrofauna (> 3 mm), density did not differ significantly among natural marsh, beach, and rip-rap habitats, but tended to be lower adjacent to bulkhead shorelines. Benthic diversity was highest at natural marshes compared to the other habitats, and the pattern was driven by forested subestuaries. Sediment characteristics varied by shoreline type and contributed to differences in benthic community structure. Given the changes in the infaunal community with anthropogenic stressors, subestuary upland development and shoreline hardening should be minimized to increase benthic production and trophic transfer within the food web.

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WETLANDS FROM DREDGE MATERIAL: ALGAL BLOOMS, TOXICITIES, AND STRATEGIES

Poplar Island, MD is a Beneficial Use Facility where relocating clean dredged material from the Chesapeake Bay shipping channels outside of the Baltimore Harbor is currently used to restore the island to its original 1847 footprint. The placement of the dredged material results in a transition from anaerobic slurry-filled cells to beneficial wildlife habitat consisting of functioning wetlands and uplands. The progression can lead to unexpected environmental issues, such as elevated nutrient and metal levels, avian bird mortalities, and the potential for toxic algal bloom-dominated subsystems. In 2012, blooms of toxic *Microcystis aeruginosa* were identified in one impoundment (cell) of Poplar Island in late summer, resulting in microcystin levels exceeding 46 ug L-1. Elevated toxin levels prevented discharge of the cell water back into the bay, through fear of possibly intoxicating harvests of blue crab (*Callinectes sapidus*) and oysters (*Crassostrea virginica*), public exposure to toxins well above the WHO guidelines (10 ug L-1) for recreational contact, and possible continued growth of the apparent halotolerant taxon in the mesohaline bay and its sub-estuaries. To determine viability of over-wintering populations as well as salinity tolerance of emergent taxa, sediment cores were collected in the spring and incubated, gradually raising temperatures to >30°C. Initial results indicated that *Anabaena spiroides*, another potential microcystin producer, not *M. aeruginosa*, became dominant. Salinity tolerance and toxin production of the emergent taxa will be determined through the summer, with a goal of identifying potential future dredged material threats to estuarine living resources and recreational users of the Bay. Additionally, dredged material and cell conditions fostering algal blooms will be used to identify possible bloom and toxin impacts, and their subsequent management, for other dredged material containment facilities and beneficial use sites.

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NUTRIENTS IN SAN FRANCISCO BAY: AN OLD ISSUE OF EMERGING CONCERN

San Francisco Bay (SFB) has long been recognized as a nutrient-enriched estuary, but one that has exhibited resistance to some of the classic symptoms of nutrient overenrichment, such as high phytoplankton biomass and low dissolved oxygen. SFB's resistance to high nutrient loads results from its high turbidity, strong tidal mixing, and large filter-feeding clam populations, all of which limit the efficiency with which abundant nitrogen and

phosphorous are converted into phytoplankton biomass. However, recent observations indicate that SFB's resistance to high nutrient loads is weakening, and that conditions are trending toward increased productivity and potential impairment along multiple pathways. These observations include: a 3-fold increase in summer-fall phytoplankton biomass in southern SFB since 1999, representing a shift in trophic status from oligo-mesotrophic to meso-eutrophic; frequent detections SFB-wide of algal species that have been shown in other nutrient-rich estuaries to form harmful blooms; an unprecedented red tide bloom in Fall 2004; and studies suggesting that the chemical forms of nitrogen may influence phytoplankton productivity and composition. To address growing concerns about SFB's changing response to nutrient loads, regulators, dischargers, stakeholders, and regional scientists are working collaboratively to develop and implement a nutrient science and management strategy for SFB. This presentation will discuss recent activities related to SFB's nutrient strategy, including: conceptual model development and identification of highest priority science questions and data gaps; estimates of external nutrient loads; monitoring and modeling program development; and assessment framework development.

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SEDIMENTARY GEOCHEMICAL SIGNATURES OF RECENT SEA-LEVEL CHANGE IN THE ESTERO DE URíAS COASTAL LAGOON, NW MEXICO

Three sediment cores were collected from different mangrove areas in the Estero de Urías coastal lagoon (southeast Gulf of California, Mexico). Under the current sea-level rise conditions, it might be expected that mangrove ecosystems follow a transgressional pattern where mangrove vegetation colonizes inshore areas. Elemental composition analysis of 210Pb-dated sediment cores were performed by X-Ray Fluorescence. Br and Rb accumulation profiles showed an increasing trend from the bottom of the core up to the surface, while Sr and Zr showed opposite trends suggesting the incursion of marine derived particles in this dominant terrigenous sedimentary environment. In this work we provide a chronology of the marine sediment fluxes and discuss the possible use of some elements as indicators of mangrove paleosalinity.

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MACROBENTHIC FAUNA DISTRIBUTION RELATED TO THE SALT INTRUSION IN A MICROTIDAL MEXICAN ESTUARY

Benthic samples and CTD profiles along the longitudinal axis of a salt wedge estuary were analyzed in order to determine the influence of the salt intrusion on the abundance, richness and distribution of macrobenthic fauna. Intensive hydrographic cruises were conducted for 40 days prior to biological sampling, during high and low tide conditions, and during dry and rainy seasons. CTD casts were taken at fixed stations covering the entire salinity gradient. Divers collected the biological samples using a 16.5 cm core, every 300m to 500m. Marine, estuarine and fresh water organisms were identified to family level. Additionally, sediment samples were collected for grain size and organic matter determination. Hydrographic data showed that the salt wedge intrusion was controlled mainly by river discharge, such that the position of the salt wedge was between <1 km to 8 km, for rainy and dry seasons respectively. In general, the distribution of macrobenthic fauna reflected the seasonal average position of the salt wedge. Some "anomalies" on the distribution were associated with grain size and/or dietary habits of organisms (e.g. grain size and organic matter concentration). The most abundant class was the polychaetes.

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A TALE OF TWO SEAGRASSES: COMPARING THE SCIENCE AND MANAGEMENT OF *ZOSTERA MARINA* AND *ZOSTERA JAPONICA* IN THE PACIFIC NORTHWEST, USA

On the Pacific coast of North America, at least two congeners of Zostera occur: native Z. marina, and introduced, Z. japonica. Z. marina is protected by State and Federal laws as essential fish habitat. Z. japonica is considered "invasive" and therefore, ecologically and economically harmful by some, while others consider it benign or perhaps beneficial. Z. japonica does not appear on the Federal or the Oregon invasive species or noxious weed lists. However, California lists it as both an invasive and noxious weed and Washington recently listed it as a noxious weed. We describe the management dynamics in North America with respect to these congener species and highlight the science and policies behind these decisions. In recent years, management strategies at the state level have ranged from protection of Z. japonica as a priority habitat in Washington to eradication in California. In 2011, Washington State reversed its long standing policy to protect Z. japonica and is developing permits for chemical control of this plant. The policy of Z. japonica removal contradicts efforts to conserve and protect seagrass in other regions of the US and around the world. We recommend research actions to assist in the assessment of Z. japonica ecology and the immediate and long-term effects of management actions.

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EFFICACY OF WAVE ATTENUATING STRUCTURES ON RESTORING SHORELINES AND EMERGENT MARSH GRASSES: A COMPARATIVE STUDY OF TWO DISTINCT TYPES OF BREAKWATERS

Efficacy of two distinct types of wave attenuating structures on restoration of eroding shorelines, submerged aquatic vegetation (SAV) and emergent marsh grasses is studied in the wind driven, moderate energy sites of northern Gulf of Mexico. Two types of wave attenuating structures studied are artificial oyster reefs and pyramid-shaped wave attenuation devices (WADs) made of concrete. A suite of variables namely, spatial and temporal expansion and density of submerged aquatic vegetation; shoreline position and density of emergent marsh grasses leeward of the structures are measured to compare the effectiveness of the wave attenuating devices. Thus far, some positive impacts on SAV attributes have been observed leeward of artificial oyster reefs, however, concrete-made WADs have been found to be more effective on curbing shoreline erosion and density of emergent marsh grasses leeward of the structure. The distance from shorelines at which the WADs are deployed is attributed to be the primary reason for positive impact on shoreline restoration and enhanced emergent marsh grass density. It is expected that the indicative results from this comparative study can be implemented in future shoreline restoration efforts.

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ASSESSING COASTAL LOUISIANA'S RESILIENCY TO DROUGHTS, FLOODS, AND HURRICANES UTILIZING DATA FROM THE COASTWIDE REFERENCE MONITORING SYSTEM

The effects of climatic events like droughts, floods, and hurricanes are magnified in Louisiana's coastal wetlands. The low-lying marshes and swamps are intimately tied to water level, salinity, and sediment availability. The landscape is complex and includes the interacting effects of Louisiana's coastal restoration efforts, riverine processes, and private land management. Responses to extreme weather events are first captured by emergent vegetation and cumulatively contribute to wetland surface elevation trajectories. Louisiana's Coastwide Reference Monitoring System (CRMS) collects hydrologic, vegetation, and elevation change data at 392 sites throughout the coastal zone for the purpose of assessing coastal restoration efforts. For this exercise, CRMS data are utilized to examine drought, flood, and hurricane impacts and to assess recovery from those events. The impacts of 2005, 2008, and 2012 hurricanes on vegetation and surface elevation trajectories are assessed. Similar storm tracks created very different outcomes due to hydrologic conditions at landfall. The 2011 drought in the western portion of the state is contrasted with the Mississippi River flood event that occurred in the eastern marshes that same year. Salinities were very high and water levels were low in the west while flood waters impacted marshes connected to the Mississippi River and Atchafalaya Delta in the eastern and central marshes. Data collected during 2012, a year with very high rainfall along the Louisiana coast, depict surface elevation increases on the order of 30 cm due to soil expansion. Marshes that had previously been solid underfoot began to 'quake'. All of these climatic events are considered relative to the resiliency of Louisiana's coast.

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REPAIRING AUSTRALIA'S TROPICAL COASTAL WETLANDS

Coastal wetlands in Australia's northeast tropics have undergone over 100 years of agricultural development, with local-scale barriers (bund walls and levees) constructed on almost every coastal stream in most drainage basins. In addition most major rivers have weirs constructed at the salt-fresh interface. Consequently, coastal ecosystems are highly fragmented, severely compromising connectivity, excising large areas of wetland and intertidal habitat from the rest of the estuary and allowing them to be converted into often unproductive agricultural land. We investigated the many attempts that have been made to remedy this habitat degradation through the removal of barriers or the imposition of fish passage devices, and found that demonstrable successes have been rare. Evaluation of the reasons for this lack of success implicates seven main causes: (1) The exact objective of restoration is often unclear or poorly specified. (2) The prioritisation process often fails to consider all potential trade-offs. (3) Past conservation and rejuvenation efforts have focused on individual spatial units rather than addressing a broader landscape or seascape context. (4) The knowledge-bases underpinning restoration decisions are often inadequate. (5) Management decisions are often based on overoptimistic expectation of clear links between actions and outcomes. (6) Demonstrating benefit is usually difficult because baselines are rarely appropriate and monitoring often inadequate. (7) Many projects fail in the medium- to long-term because of a lack of adequate continuing funding. Some of these causes are specific to the tropical estuary situation but many reflect similar issues around the world. Clearly, Australia's valuable coastal wetlands will continue to degrade until these issues are fully understood by decision makers so effective remedies can be built into future repair and remediation strategies.

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THE INTERPLAY OF CLIMATE DRIVERS AFFECTING FRESHWATER DELIVERY TO A SOUTHEASTERN ESTUARY: WATERSHED SCALE AND REGIONAL CONTEXT

Variability in watershed precipitation and streamflow to the Altamaha River estuary (GA) was examined in relation to indices for eight climate signals. Empirical orthogonal function (EOF) analysis showed that precipitation can be largely described by a temporal signal that is uniform across the watershed (EOF 1), modulated by spatial patterns along (EOF 2) and across (EOF 3) the long axis of the watershed. These patterns agree broadly with regional-scale analyses but are likely to be different from those outside the region. At this scale, even differences with neighboring states emerge. Each of these aspects of precipitation was best correlated with a different climate signal, and the dominance of climate signals changed throughout the year: EOF 1 with the Bermuda High Index in summer-fall; EOF 2 with El Niño/Southern Oscillation in winter; and EOF 3 with the Atlantic Multidecadal Oscillation in December and June. An El Niño Modoki index showed similar correlation patterns to canonical El Niño. These signals all propagated to river discharge entering the estuary 0-1 month later. Other climate signals examined (North Atlantic Oscillation, Pacific Decadal Oscillation, Pacific-North America Pattern, and North Pacific Oscillation) had few and inconsistent correlations with precipitation and streamflow. Changes in global- and regional-scale climate signals have the potential to affect the amount, seasonality, and quality of freshwater entering the estuary, influencing estuarine salinity, mixing time scales, and nutrient status. Differential propagation of climate signals through ecosystems, as e.g., a phenomenon that disproportionately affects the growing season of a keystone species, is possible with such a complex interplay of climate drivers affecting freshwater delivery.

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SIMPLE AND ROBUST INSTRUMENTATION FOR MONITORING WATER LEVEL AND CURRENTS WITH ACCELEROMETER DATA LOGGERS: EXAMPLE DEPLOYMENTS DURING IRENE AND SANDY IN WAQUOIT BAY

The SeaHorse Tilt Current Meter is an easy to use, robust current meter developed by Sheremet. Its principle of operation is based on measuring the tilt of a buoyant cylinder tethered at the bottom. The data are collected by means of inexpensive digital accelerometer loggers. The same logger is also used in an simple arm and float water level gauge. Use of a large number of low-cost yet sufficiently accurate instruments allows researches to gain a new high spatial resolution view of the oceanographic processes and improve the ocean state prediction. These instruments have been widely tested and used in various environments in the Gulf of Maine. Major fieldwork efforts were conducted in the Waquoit Bay National Estuarine Research Reserve. Up to 35 SeaHorse current meters and 20 tide gauges were deployed in the bay and adjacent ponds for the periods ranging from a week to several months in order to study the shape of the tidal signal. The instruments were placed in major inlets / channels and in a series of lines across the interior of the bay. The instruments had different ballasting and sensitivity which allowed us to optimize their performance for channel vs bay interior conditions. A focus will be given to deployments during hurricanes Irene and Sandy in order to illustrate the performance of the instruments in recording tides, storm surges, wind-driven return underflow and shorter scale seiches excited in the basin.

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MARINE VEGETATION ATLAS: AN ARCGIS SERVER APPLICATION FOR SHARING AND EXPLORING EELGRASS AND KELP DATA IN WASHINGTON

Eelgrass and kelp are marine vegetation with recognized ecological values, and have been identified as indicators of ecosystem recovery. The purpose of this project is to improve access to information on the distribution of eelgrass, kelp, and other marine vegetation in Puget Sound. Greater access to historical and current vegetation data is needed to guide management decision-making, support scientific research, and assess change over time. These actions will support the long-term protection of marine vegetation. This Marine Vegetation Atlas project will create a spatial database of historical and current observations of marine vegetation. Information from a broad range of sources will be integrated, including large area maps, scientific studies, and site surveys. The atlas will be available initially within DNR via ArcGIS. Ultimately, it will be accessible through an ArcGIS Server-based map on DNR's external website for use by managers, policy makers, scientists, and the general public.

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DEVELOPMENT OF AN INTEGRATED ECOSYSTEM MODEL FOR THE OLD TAMPA BAY WATERSHED

The Tampa Bay estuary has undergone a remarkable ecosystem recovery since the 1980s despite continued population growth within the region. However during this time, the Old Tampa Bay (OTB) subwatershed has lagged behind the rest of the Bay's recovery relative to improvements in overall water quality and seagrass coverage. In 2011, the Tampa Bay Estuary Program, in partnership with the Southwest Florida Water Management District, embarked on the development of an integrated set of numerical and empirical modeling approaches to determine the best management actions needed to improve the ecology of the OTB subwatershed. This project intends to integrate watershed, hydrodynamic, water/sediment quality, and ecological models (light and biota) to simulate changes in OTB ecology in response to the future implementation of large-scale management actions. The proposed management actions include: 1) completely diverting stormwater/freshwater input from a portion of the subwatershed that historically drained to the Gulf of Mexico, 2) diverting 90% of the directly discharged advanced wastewater treatment effluent to OTB to reuse within the subwatershed, 3) building additional bridges or raising causeways along road expanses that intersect OTB, 4) reducing stormwater nutrient loads by 25% throughout the subwatershed, and 5) various combinations of these actions, as well as, other secondary management actions. The integrated set of models will be used to evaluate the net ecological improvements to OTB's water quality (light environment and dissolved oxygen conditions), sediment quality (reduced accumulation of organic-rich sediments), propensity for nuisance algal blooms, potential expansion of seagrasses, and nekton use. Based upon this evaluation,

management actions that produce the greatest simulated improvements for the least amount of costs will be recommended for future implementation in the OTB subwatershed.

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TIDAL CIRCULATION WITHIN THE CURVED DEEPWATER NAVIGATIONAL CHANNEL OF THE NORTH PASSAGE OF THE CHANGJIANG RIVER ESTUARY

A 300 kHz ADCP was used to measure: (i) depth-averaged flow velocities at maximum ebb and flood tides at five north lines and five south lines; (ii) time series of current speed/direction over a flood-ebb tidal cycle at three hydrological gauging stations CS6, CSW and CS3' on spring tide in the flood season, on 13 August 2010. Depth-averaged tidal flow velocity data measured along the north and south sides of the curved Deepwater Navigational Channel show: (i) At the landwards end of the curved Channel, current speeds measured at the north sections LN-4, LN-3, and LN-2 are larger than those at the south sections LS-1, LS-2, and LS-3 at maximum ebb tide. At the seawards end of the curved Deepwater Navigational Channel, current speeds measured at the north sections LN-1 and LN-0 are smaller than those at the south sections LS-4 and LS-5 at maximum ebb tide. This indicates the possible presence of shear flows between the north and south sides of the curved Channel. Both "Clockwise Vorticity (CV)" and "Anti-clockwise Vorticity (AV)" are formed, respectively. Time series of tidal flow velocity data measured vertically at six layers at three hydrological gauging stations CS6, CSW, and CS3' within the curved Deepwater Navigational Channel show: (i) Current speeds and the turning time of tidal flow between flood and ebb tides differ for each of the six layers. (ii) During the turning of tidal flow from flood to ebb, rotational directions of tidal ellipses in the upper layer and the lower layer at stations are different, e.g., anticlockwise in the upper layer and clockwise in the lower layer at hydrological gauging station CS6, while clockwise in the upper layer and anticlockwise in the lower layer at hydrological gauging stations CSW and CS3'. This may suggest a pycnocline/stratification between the upper and lower layers. Key Words: ADCP; analysis; tidal circulation; North Passage; Changjiang River estuary

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THE EFFECTS OF SAV BED DIVERSITY ON SPECIES GROWTH UNDER VARIABLE SALINITY AND SEDIMENT CONDITIONS

Submersed aquatic vegetation (SAV) growing in low salinity and freshwater regions of the Chesapeake Bay and its tributaries are generally found in multispecies beds with the dominance of individual species varying in both space and time. This diversity may allow for increased bed persistence under varying habitat conditions and stresses, and increased understanding of their competitive interactions can help with management and restoration of these habitats. *Vallisneria americana* (wild celery), *Heteranthera dubia* (water stargrass), and *Stuckenia pectinata* (sago pondweed) were planted in an outdoor mesocosm designed to test their growth and competitive abilities under varying conditions of salinity (0; 5; 10), sediment type (sand vs. mud), and species combination (monoculture; biculture; triculture). *H. dubia* was the only species where biomass was sensitive to elevated salinities, while sediment type had a significant impact on both *V. americana* and *H. dubia*, with *V. americana* having greater total biomass in mud (10.5 % organic) compared with sand (0.3 % organic), and *H. dubia* performing better in sand. *V. americana* and *H. dubia* were the strongest competitors, significantly overyielding in 33% of the treatments when grown in mixture compared with monoculture, and underyielding in 5%. *S. pectinata* never overyielded in mixture, and underyielded in 56% of the treatments. Interspecific competition was strong between *H. dubia* and *S. pectinata* only under 0 salinity, regardless of sediment type. For *H. dubia*, competition only played a role when abiotic stress was minimal. *V. americana*, on the other hand, showed strong interspecific competition with *S. pectinata* across all salinity and sediment types. Complementarity was observed when *H. dubia* and *V. americana* were grown together in sand with a salinity of 10, providing evidence for increased mixed bed plant performance under conditions that would typically be stressful for each.

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ANALYSIS OF TROPHIC RELATIONSHIP OF JUVENILE ASIAN HORSESHOE CRABS ON A NURSERY BEACH IN HONG KONG

δ13C and δ15N stable isotopic analysis of trophic relationship of juvenile Asian horseshoe crabs at a nursery beach in Ha Pak Nai, Hong Kong revealed that they tended to have a mixed diet. Specifically, juvenile Tachypleus tridentaus preyed on small crustaceans (amphipods, isopods, fiddler crabs), molluscs (bivalves, gastropods) and insect larvae, whereas Carcinoscorpius rotundicauda preferred polychaetes, molluscs (bivalves, gastropods) and crustaceans (hermit crabs). The present results suggested that there might be a segregation of food preferences between these two horseshoe crab species. The data also revealed that different instar stages of the juveniles could migrate and forage to different shore levels, as shown by the differences in the values of δ13C and δ15N in their tissue as related to that for the potential prey items. From their isotopic signatures, seagrass Halophila beccarii and macroalgae Ulva fasciata and Enteromorpha linza were also shown to support carbon sources directly and indirectly to the food web, indicating the importance of vegetation on the shore faunal communities and juvenile horseshoe crab populations.

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CHRONIC TOXICITY OF CADMIUM AND TRIBUTYLTIN ON EMBRYOS AND LARVAE OF ASIAN HORSESHOE CRAB *TACHPLEUS TRIDENTATUS*

Chronic effect of heavy metal cadmium (Cd) and tributyltin chloride (TBT) on Chinese horseshoe crab *Tachypleus tridentatus* were studied in the laboratory. In the first experiment, second instar larvae of *T. tridentatus* were exposed to Cd (1 ppm and 10 ppm) and TBT (0.01 ppm and 0.1 ppm) respectively, over a period of 9 weeks. The results showed that larvae can survive in 1 ppm of Cd and 0.01 ppm of TBT during this 9-week study, with normal growth and molting cycle. Over 50% of second instars of *T. tridentatus* can also survive in 10 ppm of Cd until molting into third instars. After 29 days of exposure, significantly higher mortality was found in larvae in 10 ppm of Cd than the control group. Similarly, after 9-week exposure, larvae in 0.1 ppm of TBT showed higher mortality as compared to the control. The mortality noted in 10 ppm of Cd may be caused by the increase of water uptake and hence Cd, into the tissues during molting of the larvae. Malformation of second to fifth legs was also observed for all the molted third instars, which have been exposed to 10 ppm of Cd. In the second experiment, embryos of *T. tridentatus* were exposed to Cd (1 ppm and 10 ppm) and TBT (0.01 ppm and 0.1 ppm) respectively, over a period of 24 days. The results showed that no significant difference in survival rate was found among 1 ppm of Cd and 0.01 ppm and 0.1 ppm of TBT as compared with the control. However, the mortality of embryos in 10 ppm of Cd was at 100% and significantly higher than the control group at 40.2%. Further observations on the development of embryos under prolonged Cd and TBT exposure will be presented.

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EFFECTS OF CLIMATE CHANGE ON A RESTORED SOUTHERN CALIFORNIA SALT MARSH

Salt marshes provide many critical ecosystem functions, several of which are threatened by human activities such as urban development and climate change. Many of these systems have undergone restoration which is one method utilized to deal with these threats. Under current climate conditions restorations are known to be effective; yet the success of these restorations is unknown under altered climate regimes. Southern California is known to have a Mediterranean climate characterized rain in the winter and dry conditions in the summer. Climate change projections for this region include increased frequency of severe storms, longer periods of drought, and increases in temperature. To understand these effects I evaluated how altered precipitation (increased and decreased) and increased temperature affected a restored high marsh berm in southern California. Structures constructed of PVC pipe and greenhouse plastic mimicked these environmental changes and were placed on a high marsh berm in a randomized block design. Continuous data loggers placed within each experimental plot indicated the treatments were effective in reducing temperature and altering precipitation. Overall plant cover was reduced in treatments with decreased precipitation. These treatments had an increase in microalgae abundance which we believe was due to an increase in light availability. The invertebrate community was slower to respond to changes in climate. However treatments combining increases in temperature and precipitation had an increase in overall abundance as well as an increase in diversity of invertebrates as compared to other treatments and controls. Our final results can provide managers of future restorations information to assist in design and budgets by understanding the success of restoration under different climate change scenarios.

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PUGET SOUND MONITORING SHOWS EELGRASS (*ZOSTERA MARINA*) DECLINES

The deep, cold and well-flushed waters of Puget Sound, WA (USA) are experiencing eelgrass (Zostera marina L.) declines. Eelgrass faces anthropogenic stress from eutrophication and sedimentation to shoreline hardening, ship traffic, and aquaculture. Since 2000, the Washington State Department of Natural Resources' Submerged Vegetative Monitoring Program (SVMP) has assessed status and trends in eelgrass area and depth distribution throughout greater Puget Sound. The program assesses eelgrass at multiple spatial scales: annual Sound-wide eelgrass status; high-density sampling of sub-regions to document rates of change; and detailed assessment of specific sites. In addition, there are investigations into the major stressors affecting eelgrass. 177 of the 212 trend-analysis sites have shown no significant change in eelgrass area; however, sites with decreasing eelgrass area (25) outnumber those with increases (10). The southern part of Hood Canal, a fjord with a shallow sill at its opening, is of greatest concern, with ten declining eelgrass sites. Declines are also occurring at six sites in southern Puget Sound and six in the San Juan Islands, though monitoring in the Saratoga-Whidbey region of the central Sound reveals six eelgrass sites showing increases. At the most detailed monitoring scale, the SeagrassNet site at Dumas Bay shows eelgrass loss at both the shallow and deep transects, comparable to the adjacent declining SVMP site. The combined evidence of eelgrass declines due to human impact in Puget Sound raise a flag. Overall, our monitoring data show that the Puget Sound Partnership's goal of a 20% increase in eelgrass area by 2020 cannot be achieved with current management practices; the stresses on eelgrass must be reduced to create gains in eelgrass area and insure the health of Puget Sound.

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CHARACTERIZING THE EFFECTS OF CLIMATE CHANGE ON PHOTOSYNTHESIS FOR EMBRYONIC AND JUVENILE SPOROPHYTES OF *PTERYGOPHORA CALIFORNICA* AND *LAMINARIA FARLOWII*

Climate change driven by human activities has led to dramatic increases in atmospheric concentrations of CO2, altering global temperatures and oceanic chemistry. Atmospheric CO2, currently at 400 ppm, is predicted to reach 1000 ppm by the year 2100 and concomitantly dissolved CO2 will decrease seawater pH. Furthermore, average global atmospheric temperatures have increased ~ 1 C, causing sea surface temperatures to also rise. The physiological and ontogenetic consequences of these rapid changes have been explored in terrestrial forests and coral reefs, but remain understudied in kelp forests. In addition to providing complex habitat for commercially important organisms, kelp forests are one of the most productive marine ecosystems. Through photosynthesis and respiration, they play a key role in the coastal carbon system. Specifically, their ability to utilize both CO2 and HCO3- during photosynthesis affects the local distribution of DIC. DIC proportions are expected to shift with elevated CO2 concentrations, but it is unclear if CO2 and HCO3- uptake by kelps will differ under climate change conditions. In this study, juvenile sporophytes and spores of the prostrate kelp *Laminaria farlowii* and the stipitate kelp *Pterygophora californica* were cultured in laboratory mesocosms for 30 days in two treatments: current conditions (12 C and 500 ppm CO2) and elevated conditions (15 C and 1500 ppm CO2). For juvenile sporophytes, growth rates and DIC utilization during photosynthesis were measured weekly to determine if DIC uptake patterns changed over time. Spore development was measured every 2-5 days and DIC uptake was measured as embryonic sporophytes developed. Results from this study will be discussed.

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TRACING AGRICULTURALLY-DERIVED NITROGEN THROUGH GROUNDWATER INTO DELAWARE'S INDIAN RIVER ESTUARY

Delaware's Inland Bays are impacted by high nutrient loads and suffer from eutrophication and overall degradation. Precipitation rapidly infiltrates the sandy, porous soils of the coastal plain, carrying with it high, agriculturally-generated nitrogen loads into the aquifer; groundwater therefore asserts a dominant influence on the health of the Inland Bays. We collected groundwater samples from lysimeters and dedicated piezometers to trace the groundwater-derived nitrogen load from an agricultural field to the Indian River estuary. This field undergoes a crop rotation of corn, soybeans, wheat, and winter wheat over a two-year period; a different fertilizer regimen is applied for each crop. Nitrate and ammonium concentrations, dissolved oxygen concentrations, N_2/Ar ratios, the isotopic signatures of nitrogen and oxygen in nitrate, and concentrations of organic tracers in groundwater were analyzed to determine the total nitrogen load to Indian River, nitrogen loss via denitrification, and the primary nitrogen source. Consistent with the history of fertilizer application at this location, the isotopic signatures of nitrogen and oxygen in nitrate, from 0.5 to 4.4‰ and -7.0 to 3.0‰, respectively, point to synthetic fertilizer as the principle nitrogen source to groundwater. Nitrate concentrations ranged from 113 to 1030 μM with little indication of loss through the aquifer. Ammonium concentrations were uniformly low – from 1 to 12 μM – implying little transportation or generation of ammonium within the aquifer. Dissolved oxygen concentrations were generally too high – on average 7 mg/L – to promote denitrification. Further, N_2 concentrations and N_2/Ar ratios spanned a narrow range among the samples collected, and were not indicative of significant excess N_2. Our data indicate that the system behaves like a "pipe", funneling fertilizer-nitrogen from the agricultural field, down into the aquifer, and on into Indian River with little to no loss via denitrification.

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HYPOXIA AND OCEAN ACIDIFICATION OF THE COASTAL WATERS OF THE PACIFIC NORTHWEST: EVALUATION OF SEASONAL PREDICTIONS FROM A REGIONAL MODEL FORCED WITH THE COUPLED FORECAST SYSTEM (CFS)

A seasonal forecast system for the ocean ecosystem on the Washington and Oregon shelves is developed through a combination of a regional oxygen model designed for the coast (Siedlecki, S.A., Banas, N., Davis, K.A., Giddings, S., P. MacCready, Connolly, T., & B. Hickey. Seasonal Oxygen variability on the continental shelves of Washington and Oregon, in prep.) and the predictions from the Climate Forecast System (CFS). A model hindcast and re-forecast for 2009 are compared to local observations and show the predictive capabilities of the forecast system for SST, SSH, salinity, chlorophyll, nutrients, oxygen, and pH on seasonal timescales. The forecast for 2013 for the coast along with preliminary skill based on observations will also be presented. Challenges in forecasting on seasonal timescales in the coastal environment will be discussed.

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NUMERICAL MODELING OF AN AMAZONIAN ESTUARINE SYSTEM

Through the application of a calibrated and validated numerical model (Delft 3D) we assess the dynamics of an Amazonian estuarine system, the Taperaçú estuary (Pará, Brazil). The Taperaçú estuary is located in the world largest mangrove fringe bordering the Amazon region and is subjected to a macrotidal regime (~ 6 m spring tidal range) and low freshwater input. Field surveys conducted in the estuary, collecting parameters such as water levels along the estuary and flow velocities form the basis of the numerical model validation. Once validated, the model has been applied to better understand the processes controlling this frictionally dominated estuary. The hydrodynamic, waves and sediment transport modules of Delft 3D have been applied, including the morphological feedback in the hydrodynamics. The model domain includes the whole Taperaçú estuary, the connected Caeté estuary and the adjacent continental shelf. The whole mangrove area and creeks connecting both estuaries are included in the numerical model, allowing for a large wetting/drying area. The system hydrodynamics is largely driven by the tidal wave interacting with the complex shallow sandbars and ebb/flood channels that form the estuary. Results show the differential ebb/flow dominance throughout the estuarine channels controlling the morphology and evolution of channels and sandbars. Morphological changes in the channel-shoal patterns are dependent on flow velocity distribution and on their dependency on basin width in this funnel shaped estuary.

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THE EVOLUTION OF THE FLOWCAM – 17 YEARS IN THE MAKING

Responding to the need for the "rapid counting, imaging and measurement of individual plankton cells in natural populations", researchers at the Bigelow Laboratory for Ocean Sciences in 1999 built and installed the first FlowCAM, an imaging flow cytometer designed

specifically to support aquatic microbial research. Since 1999 over 300 FlowCAMs in over 40 countries have been put to use for the purpose of the study and monitoring of microorganisms in both fresh and marine systems. Building upon advances in technology, input from the user community, and expanded resources, engineers at Fluid Imaging Technologies, manufacturer of the FlowCAM, have transformed the FlowCAM of 1999, and now build an instrument that is vastly improved when compared to the first unit built. We present here a brief evolution of the FlowCAM, focusing on the current state of technology of the instrument. Data from various applications will discussed, along with a candid assessment of strengths and limitations of the instrument.

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SEAGRASS PHOTO-PHYSIOLOGICAL RESPONSES IN A NATURAL HIGH-CO2 ENVIRONMENT

The atmospheric concentration of CO2 has been steeply increasing over the last 200 years, with an associated increase of total dissolved inorganic carbon (Ci) and a decrease of the oceans' pH. Seagrasses are among the most productive marine ecosystems, but yet little is known on the effects of high-CO2/low pH on their photosynthetic physiology and the ecological consequences. Marine CO2 seepage areas have been used as natural laboratories to investigate the performance of marine organisms under long-term exposure to high-CO2 levels that mimic the future ocean. In this work we conducted a series of experiments comparing the photophysiology of the seagrasses Posidonia oceanica and Cymodocea nodosa, growing in the vicinity of submarine CO2 vents around the islands of Vulcano and Panarea (Aeolian Archipelago, Southern Tyrrhenian Sea, Italy). Plants growing close to CO2-seepage sites were compared with plants from control sites. Automated chlorophyll fluorometers were deployed for 24-hour periods to examine the changes in photosynthetic efficiency and energy quenching mechanisms. Samples were collected at predawn and noon and analyzed for pigment composition, antioxidant capacity, and soluble carbohydrates. Differences in gene and protein expression were evaluated as a function of Ci levels. Stable carbon isotopes (δ13C) were also analysed to investigate the contribution of volcanic CO2 to seagrass productivity. Both P. oceanica and C. nodosa plants growing in CO2-seepage sites showed lower allocation of PSII-absorbed energy to photochemistry (ϕII), while presenting higher proportions of energy dissipation by non-photochemical pathways (down-regulation, ϕNPQ and other energy losses, ϕNO). As well, diel photosynthesis-irradiance curves (ETR-I), built with data acquired over the 24-hour deployments, showed lower photosynthetic rates in plants from CO2 seepage sites. This unexpected pattern of photosynthetic activity will be discussed in light of the complementary data.

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ECOLOGICAL AND BIOENERGETICS TRADE-OFFS OF JUVENILE SALMON REARING IN THE INTERMITTENT RUSSIAN RIVER ESTUARY, CALIFORNIA USA

Juvenile salmon occupying seasonally intermittent estuaries must accommodate conflicting trade-offs among potential limiting factors of food availability, bioenergetic growth conversion and environmental stress, which likely contributes to the plasticity of their growth and life history structure. Depending on the interannual variability of river flow, coastal wind regimes and local management pressures, juvenile sub-yearling steelhead, Oncorhynchus mykiss, and Chinook salmon, O. tshawytscha, rearing in the Russian River estuary face different frequencies and durations of estuary closure that influence habitat opportunity and the capacity of available prey to support growth. Shifts in estuary volume, water quality, stratification, and prey distribution and production provide potentially conflicting trade-offs for increased availability of euryhaline, oligohaline or tidal freshwater epibenthic prey more stressful environmental conditions. Sampling of juvenile salmon distribution, diet and prey availability in the summers of 2009-2011, while never during freshwater lagoon conditions, indicated that flooding of estuary margins potentially expanded carrying capacity by redistributing juvenile salmon and prey, and potentially expanding prey production, along the estuarine gradient. Bioenergetic modeling of potential O. mykiss growth under observed fish diet composition and temperatures over 10-29 d periods of estuary closure indicated that fish in the lower and possibly the middle reaches of the estuary could be buffering stressful temperatures. However, differences between modeled and empirical growth (higher) suggested that different estuary reaches offered significantly different prey energetic values, consumption rates varied, or the fish could be taking advantage of lower temperature, somewhat hypoxic waters. Plasticity of juvenile salmon rearing patterns in intermittent estuaries like the Russian River could account for their surprising resilience and performance.

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MODEL SENSITIVITY AND ROBUSTNESS IN THE ESTIMATION OF LARVAL TRANSPORT

A popular method for predicting larval transport in estuaries and the coastal ocean is through the use of coupled ocean circulation and particle tracking models, termed "biophysical" models. This study investigates the sensitivity of larval transport predictions to three input parameters universally required for particle tracking in biophysical models; the number of particles released, the particle release depth, and the particle tracking time. Using a three-dimensional biophysical model of the Southern California Bight, estimates of larval transport are quantified using a two-dimensional vertically-integrated particle density distribution (PDD) and the difference between PDDs is assessed using the fraction of unexplained variance (FUV). Overall, our study shows that larval transport predictions are sensitive to changes in all three input parameters and that the parameters should be carefully selected in order to obtain robust estimates of larval transport. We also observed that the sensitivity scales with the strength of mixing in the system. For the number of particles released, the FUV falls off rapidly as the number of particles increases. A minimum number of particles is identified that guarantees robustness of model predictions; this number increases as the complexity of the circulation patterns increase. For the particle release depth, the FUV between PDDs grew linearly as particles are released farther apart. The FUV is also inversely proportional to the strength of vertical mixing as the FUV is smaller during the winter when a deep mixed layer and weak stratification are present than in the summer when the system is strongly stratified. For the particle tracking time, the FUV between daily PDDs is much larger for short tracking times of 15 days or less than for longer tracking times of 20 days or more, showing a dependence on the length of time the particles take to be evenly mixed throughout the system.

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MODELING BLUE CRAB (*CALLINECTES SAPIDUS*) GROWTH IN THE CHESAPEAKE BAY

The blue crab, Callinectes sapidus, supports one of the most important fisheries in the Chesapeake Bay. Managing a fishery requires a detailed understanding of the biology and population dynamics of the species involved. Mathematical modeling serves as a powerful tool in fisheries management by providing the ability to estimate population status and simulate potential management strategies before implementation. However, most present day applications in the Chesapeake Bay, due to a lack of understanding of blue crab growth, only use general estimates of growth rates. These approaches ignore several important aspects of blue crab growth and development such as the potential for growth rates to change over time, differences in growth rate by sex, and growth in discrete stages. Our objective was to develop a sex-specific discrete growth model for C. sapidus in the Chesapeake Bay. This study first adapts a previously developed, individual-based modeling approach and revises estimates of the parameters (growth per molt, molt frequency, and probability of maturation) using data from an annual winter dredge survey in the Patuxent River. We used a maximum likelihood function. Our model should provide a more reliable projection of blue crab growth in the Chesapeake, and the method could be easily adjusted and applied to different regions where blue crabs are present.

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INFLUENCE OF PROPAGULE FLOTATION AND LIGHT AVAILABILITY ON ESTABLISHMENT AND PRODUCTIVITY OF MANGROVES TRANSGRESSING POLEWARD

Global climate change events are driving the expansion of mangroves into salt marsh habitat along the Atlantic coast of Florida. The ability of mangroves to migrate poleward and displace salt marsh is due to a combination of factors, two of the main being the ability of propagules to float long distances and for seedlings to establish. To examine the differences

among species in propagule flotation periods and the influence of light availability on seedling establishment, we compared mangrove seedling growth of the three Floridian species (red, black and white). Propagules were collected along a latitudinal gradient on Florida's Atlantic coast and were grown under two light levels (sun and shade) after being floated in seawater for varying lengths of time (0,1,2,3,4 wk). Avicennia germinans propagules initially established better in the shade yet fared better in full sun, while Laguncularia racemosa propagules established better in full sun yet fared better in the shade treatment. Sun and shade establishment began to decline in both species after propagules had floated for 4 wk. Rhizophora mangle establishment was unaffected by flotation time or light availability and fared better in the shade treatment once established. Site, flotation period and light availability all significantly affected growth of the three mangrove species. Understanding the factors mediating mangrove establishment and productivity gives insight into the mechanisms behind their poleward range expansion and helps forecast the future range of this important ecosystem.

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ANALYSIS OF THE RELATIONSHIP BETWEEN VEGETATIVE COMMUNITY STRUCTURE AND GEODETIC ELEVATION FOR SALT MARSH RESTORATION IN HYPERTIDAL SYSTEMS

Monitoring salt marsh restoration sites is critical to the success of current and future projects but may also lead to costly projects. The distribution of vegetation across the marsh surface is highly influenced by soil salinity, duration of tidal flooding and competition between plant species. Focus has been placed on vegetation regeneration in post restoration activities and the role vegetation plays in sediment deposition within the Bay of Fundy. The influence that geodetic elevation has on the distribution of vegetation across the marsh has not been studied within restoration salt marshes in the Bay of Fundy. This study analyzes the relationship between vegetation community structure and geodetic elevation within restoration and reference macrotidal salt marshes in the Bay of Fundy. This research was conducted within three newly restored salt marshes (and associated reference site(s)) in the upper Bay of Fundy currently being monitored as compensation projects. Dominant vegetation and geodetic elevation were determined at sampling stations arranged in transects running from the main tidal creek to the upland for each of the study sites in 2010. Five similar salt marsh species were found in both the reference and restoration sites. These included Carex paleacea, Juncus gerardii, Spartina patens, Spartina pectinata, and Spartina alterniflora. Of these five species, Juncus gerardii, Spartina pectinata, and Spartina alterniflora were found to have significantly different means and ranges of elevation within the restoration sites as compared to the reference sites. The differences could be caused by soil salinity, frequency and duration of inundation, and competition. All of these factors are influenced by geodetic elevation and length of time since beginning of restoration.

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AN ASSESSMENT OF MARINE DEBRIS ON BEACHES AND ADJACENT OCEAN SURFACE WATERS OF THE MID-ATLANTIC BIGHT USING STANDARDIZED SAMPLING PROTOCOLS

Developing standardized protocols to quantify marine debris is important to monitor debris distribution and for evaluating debris removal programs or policies designed to reduce marine debris. We used standardized sampling protocols developed by the NOAA Marine Debris Program to evaluate their ability to quantify marine debris, monitor changes in debris density, and assess factors correlated with changes in debris density at multiple scales of spatial and temporal resolution. A nested survey design was used to sample shoreline and surface water debris at multiple scales of spatial resolution over a period of 6 months at two sampling regions representing urban and rural land use in the coastal zone of the mid-Atlantic Bight. Within the urban and rural regions, three locations consisting of three sampling sites each were sampled for shoreline debris using visual counts along standardized transects and surface water debris was sampled in adjacent ocean waters using a manta-net. Overall the sampling protocols employed in this survey are consistent and repeatable and based on our assessment would have the flexibility to serve as a guide for standardized methods for quantifying marine debris in small or large scale marine debris monitoring and assessment surveys. Debris was more common on the shoreline compared to adjacent ocean surface waters for each size class of debris and plastic was the most common form of debris observed overall. Shoreline debris density was also less variable than surface water debris at site, location and region level. Results from power analysis and survey data resampling techniques suggests that in order to decrease error in reported debris densities, shoreline surveys should be designed to assess debris at the location-level. Surface water debris sampling would require greater sample sizes than employed in this survey to assess debris at the location-level due to high spatial and temporal variability of debris in surface waters.

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ASSESSING THE BIOAVAILABILITY OF MICROPLASTIC-ADSORBED CONTAMINANTS USING LARVAL ZEBRAFISH (*DANIO RERIO*)

Microplastic pollution is ubiquitous in the marine environment. The potential for microplastics to transport harmful pollutants into the food chain is largely unknown, but often speculated, and the bioavailability of sorbed co-contaminants has received little empirical investigation. In two separate experiments, the present study assessed the bioavailability of environmental pollutants (phenanthrene and 17α-ethinylestradiol) sorbed onto the surface of unplasticised polyvinyl chlorine (uPVC) microplastic particles (200 - 250μm). Larval zebrafish, *Danio rerio*, were exposed to contaminated uPVC in static 96 h experiments. Two ecological scenarios were investigated; an aqueous dispersion represented microplastics in the pelagic zone, and particles settled to the bottom represented microplastics in benthic habitats. Using gene expression as a biomarker of bioavailability, microplastics were shown to sorb both contaminants and to alter their bioavailability. No evidence was found to suggest microplastics increase the bioavailability of co-contaminants. The present study highlights the need for further research into the ecological fate of sorbed co-contaminants; specifically, dietary microplastic exposures should be prioritized. It should be noted larval zebrafish were used as an analytical tool and it was not the objective of this study to investigate toxicity of phenanthrene, 17α-ethinylestradiol, uPVC or the mixture toxicity of these substances.

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TEMPORAL VARIABILITY IN ESTUARINE PH: A DECADE OF HIGH-FREQUENCY MEASUREMENTS FROM 15 U.S. ESTUARIES

Understanding and predicting ocean acidification impacts in estuaries is complicated by the complexity and intensity of biological and physical drivers operating in coastal environments. This has been further hampered by a relative lack of information on the present-day range and dynamics of pH occurring in estuaries. NOAA's National Estuarine Research Reserve System (NERRS) has been monitoring pH for more than a decade at 15 to 30 minute intervals. Although it uses conventional glass electrodes reporting on the NIST buffer scale, the data have the advantage of all being collected using the same manufacturer's electrode subject to the same calibration and QA/QC procedures. Time-series data for pH, dissolved oxygen, salinity and temperature were compiled from a sub-set of NERRS sites representing just those meso- to polyhaline estuaries with essentially continuous data from 2002 to 2012. Comparisons of the resulting 15 sites revealed substantial variability in pH, within and among sites. Total within-site variability (as the 10 to 90th percentile range of the 10 year record) ranged from 0.4 to 1.6 pH units among estuaries. Most sites displayed a clear seasonal pattern in pH, with maximum values in winter and minimum values in summer (mean seasonal variability ranged from 0.2 to 0.9 pH units across sites). Sites also showed substantial daily variability in pH (similar to or often greater than their mean seasonal range), with minimum daily pH ranges occurring in winter and maximum daily ranges in summer. This variability was significantly related to the daily range in dissolved oxygen % saturation, a proxy for net biological metabolism. Mean daily pH range predicted 70% of the within-site variability in pH across all estuaries. Results suggest that variations in metabolism (production and respiration) are a dominant driver of pH in most estuaries, which has significant implications for understanding future potential patterns of acidification in estuarine ecosystems.

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USING STABLE ISOTOPE ANALYSIS TO TRACK INCORPORATION OF A BEACH WRACK SUBSIDY INTO ITS SANDY BEACH RECIPIENT COMMUNITY

Spatial subsidies elevate productivity and change community composition and trophic dynamics in their recipient community. Subsidies may be important to the recipient community when high and low productivity systems are juxtaposed. Organic matter (OM) subsidies crossing an ecosystem boundary may be directly consumed, or may stimulate nutrient cycling and primary production in the recipient community. Sandy beaches are typically low productivity, low OM environments, while often located adjacent to very productive seagrass beds and mangrove forests. We examined the incorporation of OM from beach wrack into the particulate OM (POM) and dissolved OM (DOM) pools on South Florida sandy beaches. These beaches receive marine macrophyte detritus stranded as wrack, a marine subsidy that may structure and support the terrestrial community as it does in some coastal deserts. I use stable $\delta^{13}C$ isotope analysis to determine the fate of OM matter that is deposited as wrack on beaches. I established 6 plots at upper-littoral and supra-littoral drift lines on a sandy beach in Oleta River State Park, North Miami, FL, and amended them with

beach wrack composed of locally collected seagrass material. Wrack was held in place in the plots with ½ inch mesh plastic hardware cloth. Experimental wrack plots were alternated with 6 hardware cloth controls. Other debris was removed from the beach daily. After three weeks, we analyzed sediment, interstitial pore water, and wrack associated macrofauna for $\delta^{13}C$ content. Seagrass OM in beach wrack has a distinctive $\delta^{13}C$ signature, so we used this as a tracer of the incorporation of the subsidy into the interstitial food web of the sandy beach community via two pathways: direct consumption and nutrient cycling.

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PALATABILITY OF SALT MARSH FORBS AND GRASSES TO THE PURPLE MARSH CRAB (*SESARMA RETICULATUM*) AND THE POTENTIAL FOR RE-VEGETATION OF HERBIVORY-INDUCED SALT MARSH DIEBACK AREAS IN CAPE COD (MASSACHUSETTS, USA)

Intense herbivory by a growing population of intertidal burrowing crabs Sesarma reticulatum (purple marsh crabs) have denuded large areas of salt marsh on Cape Cod (Massachusetts, USA). Spartina alterniflora (smooth cordgrass) and, to a lesser extent, S. patens (salt marsh hay) have been the primary taxa affected while halophytic forb populations of Salicornia spp. (pickleweed), Suaeda maritima (sea-blite), and Limonium carolinanum (sea lavender), that normally constitute a relatively low proportion of marsh vegetation, have remained intact. In addition, these forb species appear to be colonizing some of the marsh grass dieback areas. Because the loss of vegetation results in considerable subsidence and erosion, the objective of this study was to 1) confirm whether certain taxa are unpalatable to S. reticulatum and 2) determine whether unpalatable species could be used to re-vegetate dieback areas as an interim measure to control marsh sediment and elevation loss. The results suggest that S. reticulatum prefers Spartina alterniflora over forbs and that one or all of these species are good candidates for vegetation restoration in dieback areas.

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HABITAT SETTING INFLUENCES OYSTER-MEDIATED DENITRIFICATION

Two prominent changes in estuarine ecosystem function have been nutrient enrichment and precipitous declines in the population of the eastern oyster, *Crassostrea virginica*. Historically valued as a fishery, oysters provide boarder ecological functions including water filtration and nitrogen removal. However, our ability to guide restoration efforts to maximize provisioning of services remains limited by our understanding of factors that influence spatial variability in these functions. We investigated how the habitat setting of restored intertidal oyster reefs affects fluxes of NO_{2+3}, NH_4^+ and N_2. Fluxes were measured from oyster reef sediments adjacent to salt marshes, seagrass beds, and mudflats, and analogous control landscapes without reefs under both ambient and elevated nitrate levels. Oyster reefs enhanced denitrification (N_2 production) under ambient nitrate by 18-275% over the controls, with the largest increase occurring in the mudflat landscape. Under elevated nitrate levels, reefs increased denitrification in the marsh and mudflat landscapes. These results suggest that oysters prime the sediment for enhanced denitrification in response to nutrient pulses. Under elevated nitrate levels, we found that oyster density at first increased and then slightly decreased denitrification rates. Our results indicate that oyster-mediated denitrification is dependent on the habitat setting and that oyster density is a likely a driver for this pattern. These results suggest that the landscape setting of a restored oyster reef can largely impact the delivery of services it provides, and thus should be considered carefully in restoration and management plans.

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NOAA SAN FRANCISCO BAY AREA SENTINEL SITE COOPERATIVE FOR SEA LEVEL RISE

The San Francisco Bay Area Sentinel Site Cooperative is a partnership of NOAA programs committed to coordinating efforts, focusing resources, and leveraging existing assets to address the impacts of sea level rise. San Francisco Bay is one of five sites in NOAA's Sentinel Site Program with the primary goal of improving resilience of coastal communities and natural areas to sea level rise and its impacts. The Bay Area Sentinel Site Cooperative combines and enhances current NOAA and NOAA partner efforts on climate change projects and programs addressing sea level rise and storms, ranging from Bodega Bay to Ano Nuevo along the coast, and San Francisco Bay. The Cooperative will pursue innovative new partnerships, data, tools, and information to inform decisions, develop strategies to address sea level rise impacts, and raise community awareness of those impacts. The Cooperative recently finalized an Implementation Plan and identified gaps in resources. This session will highlight successes achieved and challenges faced in the first year since the Cooperative launched. With its mix of natural resources and its population and economic centers (over seven million people and seven ports), the Bay and outer coast provide an ideal platform for a regional Sentinel program. The effort is led by NOAA's Coastal Services Center, Gulf of Farallones National Marine Sanctuary, and two NOAA-state partnerships: the San Francisco Bay Conservation and Development Commission and San Francisco Bay National Estuarine Research Reserve.

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APPLICATION OF SELF-ORGANIZING NEURAL NETWORKS TO THE CLASSIFICATION OF MARSH VEGETATION COMMUNITIES IN COASTAL LOUISIANA, USA

Vegetation community composition is often chosen as the basis for classifying wetland ecosystems because it can reflect the integration of multiple ecological processes better than any other set of factors, and patterns of co-occurring plant species can be used to infer gradients in salinity, inundation and disturbance regimes. Though linear statistical methods have long existed for community classification, assumptions for these approaches (e.g., linearity, normality) are often violated. The self-organizing map (SOM), an unsupervised neural network classification technique, is a new approach that combines ordination and clustering and is robust to skewed distributions and nonlinear relations between variables. Another key distinction from traditional multivariate approaches that makes SOMs very effective at tracking trajectories of ecological communities through time is that once an SOM is trained with a large dataset, new samples can be subsequently projected onto the trained SOM without altering the established ordination. This trait makes SOMs an ideal approach to developing community classification algorithms based on in situ community composition data. In this study, an SOM was trained from vegetation species cover data obtained at nearly 4000 marsh sites across coastal Louisiana in late summer 2007. Subdividing the trained SOM into regions that signified distinct community types was accomplished by submitting the species weight vectors of each map unit of the SOM to cluster analysis. Clear gradients in hydrologic metrics (e.g., salinity, tidal amplitude) were observed between community types. Species cover samples obtained from the Coastwide Reference Monitoring System (CRMS) and Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) monitoring were then projected onto the SOM to examine how temporal variability in community composition may respond to restoration activities, climate variability and disturbance.

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ECOSYSTEM STRUCTURE IN SEAGRASS HABITATS: WILL CHANGING CLIMATE ALTER TROPHIC LINKAGES?

Seagrasses are important coastal ecosystems for habitat provisioning and contribution to secondary production. Food web dynamics, which are of primary interest in ecology, have not been well described quantitatively for these habitats, despite strong evidence for high connectivity and rates of turnover. We used a network-based, mass-balance model, Ecopath, to describe the contemporary lower Chesapeake Bay seagrass food web. The model compartments ranged from detritus to piscivorous birds and varied in aggregation from individual fish species to plankton assemblages. Biomass and diet inputs were largely derived from recently collected empirical data and a sensitivity analysis of all input values was conducted to evaluate the model for robustness to variability. Network properties were used to describe energy flow and ecosystem structure. Effects of changing climate, which have direct impacts on seagrass health, were investigated by examining how contemporary trophic transfer differed from a hindcast scenario (-30 yr) and a forecast scenario (+30 yr), using historical data and projected impacts to seagrass systems from local climate change research. We hypothesized that decreasing seagrass biomass would negatively impact higher trophic levels in these systems, leading to decreased secondary production in this habitat. Seagrass habitats in Chesapeake Bay have recently suffered biomass losses, and the impacts to food web dynamics are unknown and may be impacted by continued habitat loss.

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A PLACE TO CALL HOME: A SYNTHESIS OF DELTA SMELT HABITAT IN THE UPPER SAN FRANCISCO ESTUARY

We used a combination of published literature and field survey data to synthesize the available information about habitat use by delta smelt Hypomesus transpacificus, a declining native species in the San Francisco Estuary. Management of this species is currently an issue

of national importance because its distribution overlaps with the water supply for 8 percent of the United States population. Delta smelt habitat ranges from San Pablo and Suisun bays to their freshwater tributaries, including the Sacramento and San Joaquin Delta. In recent years, substantial numbers of delta smelt have colonized tidal freshwater habitat in Liberty Island, a north Delta area that flooded in 1997. The species has more upstream distribution during spawning as opposed to juvenile rearing periods. Post-larvae and juveniles tend to have a more downstream distribution during wetter years. Delta smelt are most common in low salinity habitat (<6 psu) with high turbidities (>12 ntu) and moderate temperatures (7-25 C). They do not appear to have strong substrate preferences, but sandy shoals are important for spawning in other osmerids. The evidence to date suggests that they generally require at least some tidal flow in their habitats. Delta smelt also occur in a wide range of channel sizes, although they seem to be rarer in small channels (<15 m wide). Nonetheless, there is some evidence that open water adjacent to habitats with long water residence times (e.g. tidal marsh, shoal, low order channels) may be favorable. Other desirable features of delta smelt habitat include high calanoid copepod densities and low levels of submerged aquatic vegetation and the toxic algae Microcystis.

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STRUCTURAL AND FUNCTIONAL ADAPTATION OF ANAMMOX AND DENITRIFYING COMMUNITIES TO SEAWATER INTRUSION IN A TIDAL FRESHWATER ECOSYSTEM

Tidal freshwater ecosystems have experienced substantial stress from seawater intrusion due to sea level rise and increased water usage. The impacts of seawater intrusion on anammox and denitrifying communities in fresh water sediments were examined using a novel design of in situ sediment transplant experiments in the Cape Fear River Estuary (CFRE), USA. Sediment samples collected from an oligohaline site of the CFRE were placed in membrane sealed packets. The packets were placed in a transplant device and buried in oligo-, meso- and poly-haline sites of the CFRE. The sediment packets were recovered from the device at 3, 6 and 9 months. Anammox and denitrification rates were measured using ^{15}N isotope pairing methods. Both anammox and denitrification activities in the sediments transplanted meso- and poly-haline sites were repressed for the first 3 months. Anammox activities recovered after 6 months, while denitrification recovery was observed after 9 months. Changes in denitrifying community composition were examined using pyrosequencing analysis of nitrous oxide reductase genes (*nosZ*) during the denitrification recovery. Among the *nosZ* sequences assigned to *Proteobacteria*, relative abundance of *nosZ* sequences related to *Roseobacter* spp. and *Marinobacter* spp. increased while numbers of sequences associated with *Burkholderia* spp. and *Thauera* spp. were reduced. This demonstrates structural and functional adaptation of denitrifying communities to seawater intrusion in a tidal freshwater ecosystem. Pyrosequencing analysis of hydrazine oxidoreductase genes (*hzo*) will be conducted to reveal the changes in composition and diversity of anammox communities in the transplanted sediments.

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SPATIAL AND TEMPORAL VARIABILITY OF BOTTOM DISSOLVED OXYGEN CONCENTRATION IN YOUNGSAN RESERVOIR, SOUTH KOREA

To recognize the temporal variability of bottom dissolved oxygen(DO) in the Youngsan reservoir formed after dike construction, time-series data collected from one station (mean depth of 16m) exhibit bottom dissolved oxygen variations between June 13 and July 19, 2012. At the same time, water speed and direction were measured using Acoustic Doppler Current Profiler (ADCP), and temperature and salinity were measured by CTD. Based on observation data, bottom DO was closely related to River discharge and the vertical temperature gradient(T). When river discharge lasted, bottom dissolved oxygen increase from 0mg/L to 6mg/L. However, when river discharge was over, bottom dissolved oxygen quickly decreased to 0mg/l within 24 hours. Hypoxia seldom occurred when T was < 5 degree and occurred almost all the time when T was > 9 degree. Oxygen balance between vertical mixing and total oxygen demand was considered for bottom water from which oxygen demand and diffusive oxygen flux were estimated. The estimated decay rates at 20 degree ranging between 0.59~3.26 d-1 and the corresponding oxygen consumption as large as 46.9 m2d-1, respectively. After dissipation of the hypoxia, it took 0.5 to 2.2 days to reform the hypoxia. Oxygen consumed from the Youngsan reservoir was more than oxygen produced from the surface

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MARINE ECOLOGIC INDEX SURVEY OF SAN DIEGO BAY JULY 2011

San Diego Bay is the largest naturally occurring embayment in the Southern California bight (SCB), consisting of approximately 11,000 acres of marine habitat. It is home to a diverse aquatic population which helps sustain a variety of transitory fauna that utilize the bay for breeding, rearing young, and migratory respite. As one of California's five major ports it is an important hub for industry and commerce as well as home to the U.S. Navy Pacific Fleet. As a result, the anthropogenic activities may conflict with the ecological needs. Many researchers have indicated that the introduction and spread of non-indigenous marine organisms may be one of the greatest threats to the sustainability of complex marine ecosystems such as San Diego Bay. To monitor this threat periodic surveys for native and non-indigenous species populations are needed. An early detection survey was conducted to identify invertebrate species near naval facilities within the four hydrographic regions in the Bay. The main focus was the identification of native, introduced, and cryptogenic species present on multiple natural and artificial habitats within the four regions. A team of taxonomists used a modified Rapid Assessment Survey (RAS) protocol over a five day period to process live specimens living on a set of 16 settling plates placed in the bay one year prior to the survey. Specimens from preserved benthic samples taken from soft-bottom habitats in close proximity to the panels also were identified. Results presented will include the distribution of native and non-indigenous species identified on natural and artificial habitat within the four regions. Species identified in this study are similar to those reported in previous studies; however, there were some differences in spatial distribution throughout the bay. At least two previously not reported species were identified.

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SHORELINE HARDENING CAN INCREASE RECRUITMENT OF SEA NETTLE (*CHRYSAORA QUINQUECIRRHA*) POLYPS IN THE CHESAPEAKE BAY

Over the last several decades, shoreline hardening (i.e. riprap, bulkhead, etc.) has become standard practice to prevent erosion. Projected sea level rise will likely result in an increasing pressure to harden shorelines. Materials, such as granite, used to harden shorelines may provide an additional or surrogate substrate for the recruitment of many coastal and estuarine species. The scyphomedusan jellyfish, *Chrysaora quinquecirrha* (the sea nettle) is a common and abundant coastal and estuarine species found along the east coast of North America and requires hard substrate for polyp attachment as part of its development. Historically, the preferred substrate has been oyster shell. However, there is evidence that other hard substrates associated with shoreline hardening may be utilized for attachment. In 2012, we conducted a series of field experiments in the Chesapeake Bay to look at recruitment on oyster shell and granite, how tidal height might affect recruitment on granite, how the complex structure of granite might affect recruitment, and overwintering survival. Our results indicate that the practice of hardening shorelines with granite may increase sea nettle polyp recruitment, which in turn may increase medusa abundances and distributions. Increases in polyp recruitment and successful overwintering could dramatically alter planktonic food web dynamics in coastal and estuarine ecosystems, like the Chesapeake Bay.

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DINITROGEN, OXYGEN, AND NUTRIENT FLUXES AT THE SEDIMENT-WATER INTERFACE AND BOTTOM WATER MIXING RATIOS ON THE EASTERN CHUKCHI SEA SHELF

Information on benthic flux of nitrogenous species is limited in the Arctic compared to other environments. Fluxes of net dissolved N2 and O2, NO3-, and PO4-3 were measured in light and dark conditions at the sediment-water interface of whole- cores using a flow through system during late summer 2010 on the shelf of the eastern Chukchi Sea. Cold (-1.68°C) and high salinity (33.72) bottom water, characteristic of Pacific winter water-mass, overlaid sediments on the northeastern region and warm (8.33°C) and less saline (29.88) with properties of Alaska Coastal Water overlaid the southeastern area. Latitudinal variability

of gas fluxes was not associated with those of temperature or salinity. Relatively higher N2 efflux was measured for sediment located at the water mixing front between cold and warm bottom waters. Benthic O2 consumption in the southeastern region was relatively intense as were NO3- and PO4-3 effluxes from the sediments into the water column. Exposure of sediment cores to incoming sunlight did not affect benthic fluxes compared to dark conditions.

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A COMPARISON ON THE PREDICTION OF TIDAL MIXING FRONTS USING THE NONDIMENSIONAL SIMPSON AND HUNTER PARAMETER AND THE STOKES NUMBER

Thermal stratification in shelf seas results from the competition of stabilising buoyancy forces from sea surface heat fluxes against mixing due to tidal currents. If the buoyancy flux is greater than the tidal stirring stratification arises and when tidal mixing stirring is greater then the water column is mixed. There is boundary between mixed and stratified areas, this is called a tidal mixing front and it is located in areas where the tidal stirring and buoyancy forces are the same. Thermal stratification and the associated tidal mixing fronts have a seasonal scale, due to the spring-summer warming. The dynamically relevant non-dimensional parameter is the Simpson-Hunter (SH) parameter, which was originally defined as H/u3. In general tidal mixing fronts in shelf seas are located at a log10 (H/u3) = 2.7 ± 0.3. In order to obtain a more general parameter, SH should be the ratio of surface buoyancy flux to H/u3, thus representing the ratio of the stratifying to the mixing forces. To do this we use the mean surface buoyancy flux between the onset of stratification in spring and the maximum stratification in summer. The Stokes number can also be a defining parameter to predict the location of the tidal mixing fronts. This is because the Stokes number is the ratio between the bottom boundary layer height and the water depth, so tidal turbulent mixing will only reach the surface if the bottom boundary layer is at least the same size as the water depth. In this work we both numbers to predict the position of tidal mixing fronts. Preliminary results appear to show that the Stokes number is a slightly better predictor for the position of tidal mixing fronts; furthermore the use of the rotational number improves the predictions of fronts in shallow cyclonic areas of the Shelf Sea. This suggests that the effect of rotation on the water column structure will be more important in shallow shelf seas and estuaries with strong rotational currents.

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COST-EFFECTIVENESS OF TWO SMALL-SCALE SALT MARSH RESTORATION DESIGNS FOR VEGETATIVE GROWTH AND NUTRIENT FILTRATION CAPABILITY

The majority of coastal property is privately owned and divided into small tracts, however most restorations occur on large tracts of government owned property. To maximize restoration along coastlines, private property scale restoration designs must be developed and evaluated for the cost-effectiveness of vegetative growth and the ecosystem services they provide. The most valuable ecosystem service provided by salt marshes is the filtration and removal of excess nutrients prior to reaching coastal waters. In this study we planted two Black needlerush (Juncus roemerianus) restoration designs of varying cost and effort, a half-density (least costly) and a full-density (most costly). Both designs were evaluated for vegetative growth and nutrient filtration capabilities. Growth was measured as the increase in vegetated coverage area over time and nutrient filtration was quantified using an isotopically enriched 15N NO3 solution, loaded at a moderate N load of 5.38 mmols N m-2 day-1. We found the full- and half-density designs had similar vegetated areas at 2 years after planting and also removed similar quantities of N. Based on these results, we suggest the half-density design as a cost-effective restoration technique in areas of moderate nutrient loading.

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ORGANIC MATTER COMPOSITION OF EUTROPHIC SEDIMENT RESPONDS RAPIDLY TO REDUCED NUTRIENT LOADING: A FIELD AND MESOCOSM EXPERIMENT

Mitigation of nutrient inputs has had mixed success in reversing estuarine eutrophication. This is due, in part, to complex interactions between pelagic and sediment biogeochemical processes. To investigate how water column nutrient levels affect sediment metabolism and organic matter (OM) composition, I conducted two experiments in Summer-Fall 2012. In the mesocosm experiment, sediment cores from eutrophic and oligotrophic sub-estuaries of Waquoit Bay, MA, were subjected to high or low water nutrient concentrations. After 1 month, sediment metabolism and OM composition were measured. In the field experiment, sediment cores were transplanted between the eutrophic and oligotrophic sub-estuaries and changes in OM composition were tracked over 3 months. In the mesocosm experiment, net production was higher in sediments from the eutrophic vs. oligotrophic estuary while respiration was greater in high vs. low nutrient treatments. Sediment carbon : nitrogen ratio (C:N) and $\delta^{13}C$ varied according to estuary but were unaffected by nutrient treatments. In the field, sediment OM composition, estimated by C:N, $\delta^{13}C$, and fatty acid biomarkers (FA), responded rapidly to experimental treatments and changing seasons. Sediment C:N decreased in cores transplanted to the eutrophic estuary but was variable in cores relocated to the oligotrophic system. Changes in vascular plant FAs were mainly driven by season, and decreased in both sub-estuaries from July-October. Bacterial and algal FAs responded strongly to the experimental treatments and decreased in sediments transplanted from the eutrophic to oligotrophic estuary. While local deposition affects surface sediment OM composition, results from this short-term experiment are integrated over several centimeters and likely reflect changes in OM processing. Mesocosm and field results indicate that sediment processes respond rapidly to changes in nutrient loading and provide insight to estuarine recovery from eutrophication.

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HIGH DENSITY SPATIAL MAPPING OF WATER QUALITY PATTERNS REVEALS IMPACTS OF FRESHWATER INPUTS IN FLORIDA BAY, USA

Water quality is monitored in Florida Bay to evaluate the potential impacts of water management activities as well as restoration projects. One component of this monitoring (termed Dataflow) uses high speed, flow through sampling technology to produce ultra-high resolution (100 m) surveys of key water quality parameters including salinity, chlorophyll, turbidity, and colored dissolved organic matter. We found that surveys using this technique were particularly well-suited to mapping in Florida Bay where water bodies are highly fragmented by shallow submerged banks and impermeable land barriers. In contrast to discrete sampling or fixed instrumentation platforms, Dataflow was able to resolve fine scale water quality features. We examined these features in relation to diffuse freshwater inputs from contributing tidal creeks. Using pixel-level raster regression we found that the strength of the relationship between water quality features and nearby hydrologic inputs is dependent on landscape position. In particular, it was apparent that Everglades discharges from Taylor River were highly influential, despite their relatively low magnitude. This has implications regarding the monitoring of specific tidal creeks as sentinels of ecosystem condition.

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SUBMERGENCE VULNERABILITY INDEX DEVELOPMENT AND APPLICATION TO COASTWIDE REFERENCE MONITORING SYSTEM SITES AND COASTAL WETLANDS PLANNING, PROTECTION AND RESTORATION ACT PROJECTS

Since implementation in 2003, Louisiana's Coastwide Reference Monitoring System (CRMS) has facilitated the creation of a comprehensive dataset that includes, but is not limited to, vegetation, hydrologic and soil metrics collected from 392 wetland monitoring sites. The primary impetus for this monitoring program is to assess restoration efforts across the coastal zone, which includes forested wetlands, floating marshes and emergent marshes. A team of scientists from various state and federal natural resource agencies and universities has been assembled to develop approaches to synthesizing CRMS monitoring data to provide multi-scaled evaluations of Louisiana's coastal wetlands. Several indices focusing on vegetation, hydrology and landscape change have been developed to facilitate data synthesis and interpretation. The Submergence Vulnerability Index (SVI), described here, integrates wetland surface elevation, sediment accretion and hydrologic data to assess the vulnerability of a wetland based on its ability to keep pace with sea-level rise. The SVI represents the interaction between site-specific measurements of surface elevation dynamics and site-specific relative sea-level rise, and therefore is not constrained by the differences in temporal and spatial scaling that are present when comparing regional records of sea-level rise and site-specific metrics. We describe the development of this index and provide examples of how it can be incorporated into monitoring programs at project, hydrologic basin and coastwide scales to assess restoration program effectiveness and vulnerability to sea-level rise.

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BENTHIC MICROBIAL RESPONSES TO INTERACTING PHYSICAL-BIOLOGICAL DRIVERS IN A SHALLOW ESTUARY

The benthic microbial community, including microphytobenthos (MPB), plays an important role in regulating benthic metabolic and nitrogen (N) cycling processes and nutrient fluxes in shallow photic estuaries such as the New River Estuary (NRE), NC. Benthic processes may be controlled by numerous interacting drivers, including light availability, temperature, salinity, and nutrients, all impacted by weather and season. We conducted a seasonal study at six shallow water sites (0.5 m MLW) from 2008-2011 in the NRE to assess the effects of these drivers on sediment properties, metabolism, nutrient fluxes, and N-cycling rates (ammonification, N-fixation, denitrification). To assess water quality across the entire estuary, Dataflow surface water quality mapping surveys were conducted seasonally along the shallow shoreline of the NRE over a four-year period. Greater freshwater discharge due to storm events decreased salinity and increased delivery of nutrients, chromophoric dissolved organic matter, and suspended solids to the NRE resulting in decreased light availability and MPB biomass (chlorophyll a), thereby affecting benthic gross primary production (GPP), respiration (R), and net community production (NCP). Temperature increased GPP, R, N-fixation, and ammonification with the strongest effect on R. Denitrification responded to salinity and nitrate availability. By determining sediment net trophic status, benthic metabolic processes in turn regulated ammonium fluxes, mineralization, denitrification, and N-fixation. However, many of the physical-biological drivers co-varied, making it difficult to assess their relationships to specific benthic responses. We used structural equation modeling to explore these interactions and partition the direct and indirect effects of the drivers on metabolic and N-cycling processes, as well as assess the interactions between metabolic rates and N-cycling.

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PUGET SOUND WEATHER, PHYTOPLANKTON, AND NUTRIENTS: WHO'S DRIVING THIS TRAIN?

As part of a long-term marine water quality monitoring program, the King County Dept. of Natural Resources & Parks has collected nutrient and chlorophyll-a data for almost 20 years at multiple locations in the Puget Sound Central Basin. This monitoring program has yielded a unique dataset for evaluating the impact of climatic conditions on the phytoplankton and nutrient dynamics within the Central Basin. Samples collected from multiple depths at each of 14 sites, including wastewater treatment plant and combined sewer overflow outfalls, are analyzed monthly. Samples are also collected and analyzed bi-weekly from March through October at three of these sites. Phytoplankton species and relative abundance data have been collected at the three bi-weekly sites since 2008. In addition, in situ moorings have been deployed at three locations to collect data (chlorophyll-a, dissolved oxygen, salinity, temperature) at 15-minute intervals since 2008. A nitrate sensor was added at one location in 2009. It is apparent that weather and climate conditions have played a large role in the timing and extent of phytoplankton blooms in Puget Sound, particularly over the last two years. Long-term nutrient and chlorophyll data, together with the more recent phytoplankton community data, were analyzed in conjunction with local weather and large-scale climate patterns in order to determine key climatic factors regulating the interplay between nutrient and phytoplankton dynamics over different temporal scales. Over the last two years, phytoplankton seasonal bloom events were influenced by unusually cold and wet spring weather patterns, with a subsequent effect on nutrient concentrations. This type of analysis underscores the importance of factoring in weather patterns when assessing the association between phytoplankton and nutrients.

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ORGANIC DEPOSITION AND SEDIMENT ACCRETION IN THE NUTRIENT RICH TIDAL MARSHES AT POPLAR ISLAND, MD

At Poplar Island, Spartina alterniflora growth, decomposition, and elevation change is compared in marshes created from extremely nutrient rich material dredged from upper Chesapeake Bay, and sand, a low nutrient substrate. Nitrogen in the dredged material has led to initial root:shoot ratios (RSRs) <0.1, some of the lowest reported, compared to ~0.4 in the low nutrient (sand) marsh. Minimal below-ground production in the dredged material marshes raises concerns about their sustainability in a region where local SLR is ~3.2 mm per year over the last century (double the global average) and projected to at least double in this century. The contribution of organic matter to sediment accretion is thought to be critical to long term success at Poplar Is., where upland inorganic inputs are limited. In most natural marshes the largest contribution to sediment accretion is organic deposition from roots and rhizomes; however shoot production is heavily favored for several years in the dredged material marshes at Poplar Island. As they age, declines in sediment nitrogen availability result in less shoot biomass, and increasing root and rhizome biomass. As other studies have suggested, decomposition rates of shoot biomass (using litter bags) are most rapid in the first 3-6 months and are correlated to initial plant tissue nitrogen concentrations. However, after 12 months there is surprisingly little difference in decomposition rates between marshes despite differing soil N availability, suggesting that increased shoot growth may compensate for lower root and rhizome production at Poplar Island where tidal exchange is currently restricted, limiting the removal of litter from the marsh surface. This may help account for similar elevation change (~1 cm per year) across substrates and over time, despite differences in sediment N availability.

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TO THE SHELF, AND BEYOND! DISCRIMINATING MACROBENTHIC INVERTEBRATE COMMUNITIES ON THE CONTINENTAL SLOPE OFF SAN DIEGO, CALIFORNIA

The City of San Diego conducts one of the most extensive benthic monitoring programs in the world, regularly collecting about 240 samples per year from ~100 sites at mostly continental shelf depths (≤ 200 m). Consequently, benthic conditions are fairly well understood on the mainland shelf off San Diego, while less is known about the benthos in adjacent deeper continental slope waters. In order to address this issue, the City began targeting additional sites at slope depths 10 years ago as part of its regional monitoring efforts and enhanced special studies. From 2003 to 2012, a total of 79 quantitative 0.1 m^2 soft-bottom grab samples, sieved through a 1-mm mesh screen, were collected at depths ranging between 199–1023 m. Almost 7400 macrobenthic invertebrates were captured in these samples, representing about 500 species. Diversity was highly variable, with species richness ranging from 8 to 126 species per grab. Macrofaunal abundance also varied considerably, ranging from 10 to 412 animals per sample. Polychaete worms accounted for about 57% of all animals captured, molluscs 22%, crustaceans 12%, echinoderms 7%, and all remaining taxa combined about 2%. Preliminary classification analysis discriminated eight ecologically-relevant clades (communities), which separated primarily along depth and sediment grain size gradients (i.e., upper vs. middle vs. lower slope; coarse vs. fine sediments). Details of these macrofaunal assemblages on the San Diego slope will be presented along with comparisons to sediment composition, as well as additional work being conducted as part of the 2013 Southern California Bight Regional Monitoring Program (Bight'13).

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DEVELOPMENT OF AN ECOHYDROLOGICAL SALT MARSH MODEL

Terrestrial nitrogen input to coastal waters is a critical water quality problem nationwide. Even in systems well described experimentally, a clear understanding of process-level hydrological and biogeochemical controls can be difficult to ascertain from data alone. For example, an empirical mass-balance approach to characterize the nitrogen flux between a small, meso-haline salt marsh and its estuary in central Oregon yielded an extensive set of flow and water chemistry data, but a significant population of the nitrogen fixer Alnus rubra (red alder) in the upland catchment led to large, highly variable, and diffuse nitrate inputs. This, along with difficulties balancing the water budget, led to large uncertainties in the nitrogen budget. Accordingly, we used these data as a foundation for a more detailed analysis using a process-based model. We augmented the existing terrestrial ecohydrological model, VELMA, which has been used to simulate effects of climate and land use on daily carbon, nitrogen and water dynamics in forested and agricultural watersheds, with a tidal wetland submodel using a sub-daily time step. This extension was undertaken to estimate more accurately (1) terrestrial and estuarine inputs of water, carbon and nitrogen to the marsh, and (2) process-level hydrological and biogeochemical interactions controlling net nitrogen fluxes between marsh and estuary. Here, we will present the structure of the model, its parameterization for a small salt marsh on the Yaquina estuary (Oregon, USA), and preliminary results simulating the exchange of water and nutrients between the uplands, marsh, and adjacent estuary.

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HISTORICAL ANALYSIS OF COASTAL WETLANDS AS A TOOL TO HELP IMPROVE RESTORATION PLANNING FOR THE BALLONA WETLANDS

Resiliency in coastal wetland restoration is an often stated goal. However, achieving this goal in light of existing infrastructure constraints and future sea level rise can be challenging. An important early step is to establish reasonable expectations that consider inherent landscape constraints and existing coastal processes, such as geologic setting, watershed output, and coastal sediment transport patterns. Historical analysis is a powerful tool that can help provide insight to formative structure and process in coastal ecosystems. Understanding the state and dynamism of conditions under less constrained historical conditions can inform decisions about future restoration and management. Furthermore, observations of coastal systems under different hydrologic conditions can help guide deliberations about management in light of future sea level rise. We will demonstrate application of these concepts for the planning of the Ballona Wetlands restoration in southern California. Numerous data sources, such as coastal topographic maps (t-sheets), Mexican land grant sketches, US General Land Office maps, irrigation maps, soil surveys, early aerial photographs, oral histories, ground photographs, field notes, and herbaria records were compiled and synthesized to provide insight into historical wetland and riparian habitats and how they changed over time. This analysis was contextualized against a reconstruction of the historic wetland condition in the entire Bight using coastal t-sheets. The results of the analysis are being used to help guide discussions about future restoration planning and strategies to improve long-term resiliency.

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BIOGEOCHEMICAL PROPERTIES AND ECOLOGICAL CONSEQUENCES OF THE 2011 AND 2013 FLOODS IN MORETON BAY, QUEENSLAND, AUSTRALIA

Coastal habitats along the Queensland coast are regularly exposed to pulsed river discharges associated with cyclones and tropical depressions; however the scale and continuity of flooding occurring in Queensland in January 2011 and two years later in 2013, has not been seen for a very long time and was of a magnitude beyond our present capability to predict the likely consequences to iconic coastal ecosystems such as the Moreton Bay. As soon as practicable, multi-institutional campaigns were quickly mounted to monitor the effects of the floods on the catchments, rivers and estuaries and the flood plumes entering Moreton Bay. As well as traditional monitoring methods a range of innovative sensors and platforms were used to measure the immediate as well as the longer term (~ 1 year) impacts of the floods on the geology, biogeochemistry and ecology of these environments. The results of these studies have been used to better constrain both catchment and receiving environment models, and has catalyzed efforts to develop operational forecasting to better respond to future events. This presentation will overview some of the key results from these monitoring and modeling studies and comment on how these measurements provide insight into the recovery and resilience of these ecosystems, and reflect on how we might better respond to future events.

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LARGE EURYHALINE PREDATORS AND BIG FLOODPLAIN RIVERS OF SOUTHWEST FLORIDA: WHAT'S THE CONNECTION?

The subtropical rivers of southwest Florida are home to large-bodied fishes, namely smalltooth sawfish Pristis pectinata, an endangered species that uses estuaries during their first 2-3 yrs of life, and common snook Centropomus undecimalis, a recreationally-important fish that uses rivers as a major habitat. Sampling for sawfish occurred throughout a large estuary; however, specific locations near river mouths had the greatest catch rates. Generalized additive models and linear regression of sawfish tracking data found that the distribution of sawfish was significantly related to 90-day lagged salinity; sawfish moved downriver with decreasing salinity. The lags apparent in the regressions could have occurred for at least two reasons: juvenile sawfish (1) may have strong affinities for specific sites or areas of the river and remain there until conditions change enough for them to respond by relocating; (2) respond to indirect effects of salinity, such as the redistribution of prey populations that are known to exhibit similar distribution responses to lagged environmental changes. Farther upriver, electrofishing sampling for snook was conducted in fresh waters. Mean annual abundance and condition of snook (i.e., weight relative to length) were positively related to mean annual river flow (R2=0.95) and the number of days that the river reached a stage of 2 m (R2=0.82), respectively. In flood years, snook abundance increased up to 3X and their condition increased up to 1.2X. It appears that a portion of the snook population moves from the estuary into rivers to take advantage of abundant food resources that are concentrating in the river channel as waters recede from the floodplain. These results demonstrate the connectivity of freshwater inflow and riverine prey production to the movement patterns and condition of euryhaline predators, which likely affects the transfer of energy from freshwater floodplains to estuarine and marine habitats.

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CAN WE BUILD TIDAL MARSHES IN ESTUARIES TO KEEP ABREAST OF SEA-LEVEL RISE?

The rate of sea-level rise has been about 3.2 mm per year in Upper Chesapeake Bay over the last 100 years, almost double the global mean. Many tidal marshes around the Chesapeake have not kept abreast of that rate in the last century and there is interest in restoring marshes to offset losses (which may be as much as 1% per year) using dredged materials. The largest tidal marsh restoration in the Bay is on Poplar Island where 230 hectares is being planted principally with Spartina alterniflora in the low marsh and Spartina patens in the high marsh. There have been management concerns that marshes created with nutrient rich dredged material may not have enough root production for organic accretion to keep abreast of projected sea-level rise, which could increase 2x or even 3x by 2100. In addition, marshes created on restored islands may not have enough incoming sediment (from upland sources and shoreline erosion) to augment in situ Spartina production. As part of the overall monitoring effort at Poplar Island, numerous deep rod-sediment elevation tables (rSET's) were established to monitor net elevation change in three wetland cells. Monitoring of the first cell created entirely with dredged material from the Upper Bay began in 2008 and indicates that elevation is increasing at rates 2-3 times current rates of sea-level rise. Though this would accommodate increasing sea-levels through this century, there are questions whether some portion of the increase in elevation is due to factors which might be negligible in the future, including expansion of dredged material which occurs as surficial sediment horizons hydrate after exposure to tides, as well as erosion of creek banks which may provide in situ sediment subsidies to the marsh surface. We are also investigating whether there is enough flood-tide dominance to provide these marshes with particulates which could promote sustainability.

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INCORPORATING SCIENCE AND ADAPTIVE MANAGEMENT TO FACILITATE SUSTAINABLE BARRIER ISLAND RESTORATION PRACTICES IN MISSISSIPPI, USA

Restoration of coastal ecosystems has emerged as a high priority because of the ecosystem services they provide combined with their vulnerability to climate change impacts. Under the Mississippi Coastal Improvements Program (MsCIP), the USACE is investing in comprehensive barrier island restoration while using a science-based decision-making approach to better design and manage these efforts. The fundamental objective of the MsCIP barrier island restoration is to restore the integrity of the barrier islands (by increasing sediment input to supplement sediment transport processes), ensuring their ability to provide geomorphic and hydrologic form and function and to conserve essential habitats for species of concern. A scientific evaluation of historical dredging records, shoreline and bathymetric surveys was used to quantify littoral sand flux and potential impacts of dredging activities on transport quantities. The developed sediment budget documents long-term sediment transport pathways and short-term tropical cyclone geomorphic changes and was used along with hydrodynamic and geomorphic modeling to design the barrier island restoration template. A long-term monitoring and adaptive management program is being integrated into MsCIP to directly incorporate scientific uncertainties and technological challenges inherent with large-scale restoration projects. Such monitoring and adaptive management will allow the USACE to assess short and long-term impacts, restoration progress, and will provide the information needed to adjust project performance to meet goals and objectives. This presentation will describe how the historical sediment budget and geomorphic change science informed the development of performance measures and barrier island design template targets, and how the adaptive management program will use this information to address uncertainties about future system change to guide adaptive decision-making within the context of project sustainability.

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CHARACTERIZING HYPOXIC EVENTS AS AN ASSESSMENT TOOL FOR MANAGERS WITHIN NARRAGANSETT BAY, RI

The Narragansett Bay Fixed-Site Monitoring Network (NBFSMN) was created to analyze the spatial and temporal distribution of hypoxia in Narragansett Bay. This network is useful for determining influences of management strategies on water quality improvements related to low oxygen events within Narragansett Bay. The data generated from the network time-series records for 11 years (2001-2012) of temperature, salinity, chlorophyll and dissolved oxygen records are used to characterize and analyze hypoxic events within the bay. Seasonal intermittent hypoxia events with the potential to threaten ecological health have been documented in Narragansett Bay, RI from June-September, with occasional events occurring in May and October. The upper most reaches of the bay, such as embayments and headwaters, consistently report a minimum of 27 hypoxic days (daily average oxygen < 2.9 mg /L) per year, with inter-annual variability of +16-70 days. Based on previous work, these hypoxic events are intermittent and are correlated with river flow and temperature. Years with higher numbers of hypoxic events have anomalously large summer seasonal river runoff and/or high spring/summer temperatures. Years with the lowest temperatures and low flow from river runoff are correlated with the fewest hypoxic events. Based on the inter-annual variability in seasonal hypoxia, all years will be grouped for analysis based on intensity of seasonal forcing factors, such as, river flow and temperature. The group years will be examined to determine any relationships between events (durations/intensity) and implemented nitrogen nutrient reduction designed to improve water quality with respect to hypoxia. This examination will include an analysis of chlorophyll levels to determine any links to water quality improvements, such as nitrogen reductions, that are currently being implemented within the Narragansett Bay watershed.

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BIOLOGICAL AND PHYSIOLOGICAL CONDITION OF JUVENILE CALIFORNIA HALIBUT (*PARALICHTHYS CALIFORNICUS*) EXPOSED TO A CONTAMINATION GRADIENT IN MISSION BAY, CA

California halibut (Paralichthys californicus) is a commercially important flatfish species that uses bays and estuaries as nursery habitats during the first year of life. Mission Bay, San Diego, is a productive, Mediterranean-type estuary with an urban watershed that channels contaminants into the bay via three creeks and ~100 storm drains. Mission Bay is well-flushed by tides near the mouth (front bay area) and poorly-flushed in sections remote from the mouth (back bay), with a gradient of sediment quality from the contaminated back bay to the relatively uncontaminated front bay. Highest concentrations of metals (Cd, Cu, Pb, Zn), PAHs, fipronil and pyrethroids have been found in the back bay, which is shallow with fine sediment. Contaminant concentrations are not high enough to be acutely fatal to juvenile halibut; however, the combined sublethal effects of these contaminants have not been evaluated previously. The purpose of this project is to compare bioavailable metals and organic contaminants in sediments to tissue metal loads and a combined biomarker index in juvenile California halibut caught in different parts of Mission Bay. Larger juveniles were caught in the back bay and had lower hepatosomatic indicies (HSI) than fish from the front bay, indicating increased metabolic demand, perhaps in response to contaminant exposure. Halibut from the back bay had elevated levels of EROD (indicating exposure to planar aromatic hydrocarbons) and TBARS (a measure of lipid peroxidation) in the liver, kidney and gills. Fish from the back bay also had higher concentrations of 3-, 4-, and 5-ring bile FACs (reflecting PAH metabolism) than fish from the front bay in most cases. The correlation between sediment contamination and biological and biomarker responses suggest that juvenile California halibut are affected adversely by contaminated sediment. Although these effects are sublethal, they still may come at an energetic cost that could affect individual fitness.

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THE EFFECT OF OCEAN ACIDIFICATION ON OTOLITH GROWTH IN THE MUMMICHOG (*FUNDULUS HETEROCLITUS*) AND THE ENDANGERED RED PORGY (*PAGRUS PAGRUS*)

By the year 2100, it is projected that atmospheric CO2 concentrations could rise to approximately 1000 ppm, accelerating ocean acidification (OA). Studies have shown that under current conditions, OA has negatively impacted marine calcifying organisms due to changes in the calcium carbonate (CaCO3) system. Most research on marine organisms has focused on calcifiers, such as coccolithophorids, corals and mollusks, while very little has been dedicated to researching its implications on fish. Otoliths are an important boney structure in fish that act as an "earbone" aiding the fish in its sense of sound, balance, and acceleration. The otolith is a calcified structure that is generally composed of aragonite, a form of CaCO3, and therefore it is thought that it may be susceptible to the effects of OA. To better understand the consequences of OA on otolith growth in fishes, we built an OA system that consists of (6) 19L aquariums housed in a thermostated water bath capable of maintaining the temperature to within 0.1°C. This system is designed to bubble premixed air of known CO2 concentrations into the aquariums to adjust pH. We have employed this system to test the effects of OA on otolith growth in the mummichog (Fundulus heteroclitus), and current research is examining red porgy (Pagrus pagrus) otolith growth. We reared mummichog and red porgy larvae under three pCO2 concentrations: the present atmospheric level of 390 ppm (control); the year 2100 projected level of 1000 ppm, and 2500 ppm over a period of 5 days. We found that the mummichog otoliths did not change in size with decreasing pH. These results were anticipated as they are an estuarine baitfish well adapted to harsh environmental changes, including large fluctuations in pH levels.

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COMBINED EFFECTS OF ANTHROPOGENIC NUTRIENT LOADING AND EPIBENTHIC JELLYFISH BLOOMS ON BAHAMIAN SEAGRASS BEDS

Anthropogenic nutrient loading is one of the greatest threats to coastal ecosystems. In seagrass habitats, harmful effects of excess nutrients have been well-documented. One potential impact of nutrient loading is the proliferation of native species, like the upside-down jellyfish, *Cassiopea spp.*, which have been shown to increase in human-impacted areas, as well as affect benthic community structure in seagrass beds. While studies have discussed how human disturbances driving jellyfish blooms may alter marine ecosystems, there is little empirical evidence to support these claims. Therefore, in this study, we sought to identify the potential combined effects of anthropogenic nutrients and jellyfish blooms on seagrass community structure and function. To analyze this question, we conducted a press experimental design in which we repeatedly added jellyfish and nutrients (in isolation and together). Results suggest that jellyfish and nutrients have greater impacts on seagrass ecosystems than jellyfish increases or nutrients alone. Seagrass percent cover, shoot densities, taxa abundance and richness were all lower in jellyfish-nutrient plots than in other treatments. Grazing scar frequency was substantially greater on seagrass leaves from nutrient plots than jellyfish treatment plots, suggesting that grazers avoid consuming seagrass when jellyfish are present. Additionally, jellyfish growth increased as a function of nutrient input, however nutrient concentrations and seagrass morphometrics varied little across treatments. Our results support the idea that human-driven jellyfish blooms may impact marine habitats.

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NITROGEN AND CHLOROPHYLL A FLUX BETWEEN A RESTORED TIDAL MARSH AND AN ADJACENT BAY IN THE SAN FRANCISCO ESTUARY

Historically, the San Francisco Estuary (SFE) was surrounded by over one hundred thousand acres of tidal marsh; today roughly 5% of these marshes remain. Large-scale tidal marsh restoration is proposed for the SFE as a means for improving ecosystem function, though few data exist to understand the biogeochemical significance of increasing these habitats in the SFE. Urban and agricultural nutrient loads have increased nutrient concentrations in an already nutrient-replete ecosystem and the over-enrichment in some forms of nitrogen has been implicated in diminished phytoplankton-derived organic matter production. The loss of tidal marsh likely reduced marsh-derived organic matter as well. Reductions in organic matter supply from these phytoplankton and tidal marshes have resulted in disruptions at all pelagic trophic levels. It is generally accepted that tidal marshes help to remove excess nitrogen from adjacent bodies of water and also provide organic carbon to the pelagic food web, however, newly restored marshes are infrequently studied to determine if they are performing these expected ecosystem services. The goal of this study is to quantify nutrient and labile organic matter exchange between a restored tidal marsh and the adjacent open water bay. It is hypothesized that increased tidal marsh habitat will act as an inorganic nitrogen sink and an organic carbon subsidy for the SFE. The significance of these results may further support the paradigm that tidal marshes, including relatively newly restored marshes, mediate the impact of anthropogenic nutrient supply in estuaries, while fueling upper trophic levels.

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ASSESSING THE EFFECTS OF SEDIMENT-ASSOCIATED HYDROCARBONS ON BIOTURBATION AND SEDIMENT PROPERTIES FOLLOWING THE BP OIL SPILL

In 2010 the BP oil spill discharged approximately 5 million barrels of crude oil into the Gulf of Mexico. Although the spill location was offshore, wind and currents advected oil into many adjacent coastal marshes. The mixing of sediments through infauna bioturbation is an important ecosystem function that regulates sediment geochemical and physical properties. The sessile nature of infauna makes them susceptible to changes in the surrounding environment. Consequently, any long-term impacts from the BP spill that affects infauna will alter their ability to bioturbate, and cascade to other ecosystem processes such as nutrient and organic matter cycling. In the fall of 2012 we deployed Wormcam, a real-time in situ benthic observing system, at an oiled and unoiled marsh location in Terrabonne Bay, LA. At the oiled site, during high wind events, we documented the 'outwelling' of previously sequestered hydrocarbons from the adjacent marsh, into the subtidal. Levels of bioturbation were significantly less at the oiled site, documented by reduced depth, length, and production of burrows. Infauna avoided distinct hydrocarbon layers in the sediment, and this altered behavior diminished the area of influence of these bioturbators. This study provides in situ evidence of the impacts of the BP spill on processes structuring the sediment-water interface in Louisiana marshes 2 years post spill.

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WHEN TO BOLT, FRY OR SMOLT? USING OTOLITH STRONTIUM ISOTOPES TO DETERMINE JUVENILE SALMON MIGRATION PATHWAYS AND SURVIVORSHIP ACROSS PHENOTYPES, POPULATIONS AND HYDROLOGIC REGIMES

The maintenance of life history diversity within and among populations is thought to be critical for the long-term persistence of salmon stocks. Asynchrony among populations can buffer stock complexes against environmental change and provide a stabilizing 'portfolio effect'. Preserving and restoring diversity in life history traits is thus central to many recovery efforts, but it is necessary to first understand the way in which environmental factors affect their expression. Juvenile Chinook salmon leave their natal rivers at different sizes, ages and times of the year. Rotary-screw trap (RST) sampling in the California Central Valley has indicated that in wetter years, the majority of juveniles emigrate as fry (<55mm), presumably rearing downstream in the mainstem, delta and/or estuary, while in drier years a greater proportion emigrate as parr (55-75mm) and smolts (>75mm). Here, we used otolith ("earstone") Sr isotopes in adult salmon returning to the Stanislaus and Tuolumne Rivers to determine the influence of river conditions on juvenile outmigration patterns, habitat use and survivorship. Paired otolith and scale samples were used to reconstruct size-resolved outmigration patterns of successful salmon in an 'Above Normal' (2000) and a 'Below Normal' (2003) water year type. Differences in precipitation patterns and local water operations resulted in contrasting flow regimes across years and adjacent rivers. For each returning adult, the size that it had emigrated from its natal tributary was reconstructed by coupling otolith strontium isotope and radius measurements. Juveniles were classified by size, and the proportions of fry, parr, and smolt captured at RSTs were compared with those reconstructed in the adults from the same cohort, and used to estimate survivorship of different juvenile life history types. Spatiotemporal patterns in outmigration behavior and survival are discussed in the context of salmon life history diversity and the portfolio effect.

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SOUTHEAST COASTAL OCEAN OBSERVING REGIONAL ASSOCIATION DATA MANAGEMENT SYSTEM: FOSTERING DATA ACCESS AND VISUALIZATION OF COASTAL OCEAN OBSERVATIONS IN THE SOUTHEAST US

The Southeast Coastal Ocean Observing Regional Association (SECOORA) is one of the eleven coastal ocean observing regional associations partnered with the US Integrated Ocean Observing system. The SECOORA footprint encompasses coastal estuarine and ocean waters of North Carolina, South Carolina, Georgia and Florida. Numerous estuaries in the SECOORA footprint connect the watersheds of the southern Appalachian mountains to coastal waters. These varied estuarine systems, from broad lagoons to denditric marshes with varying tidal ranges, also are influenced by shelf processes and establish a strong connectivity between the land and the sea. SECOORA has implemented an end-to-end Regional Coastal Ocean Observing System (RCOOS) for the Southeast that leverages, integrates and augments existing observational, modeling, data management, education and scientific assets within the region. We are creating customized information and products to address these thematic areas: Ecosystems, Water Quality and Living Marine Resources; Marine Operations; Coastal Hazards; and Climate Change. SECOORA has established a robust data management and communications infrastructure and is implementing the US IOOS recommended standards that promote interoperability, discovery, efficient data aggregation, access, sharing, visualization, and use of coastal ocean data (physical, chemical, biological and geological). Information products are made available in near real time to stakeholders and decision makers via the SECOORA data portal (www.secoora.org). In collaboration with our state, federal and academic agencies partners within our region, we recently have also built and released a Regional Information Management System (RIMS)

through the Governors' South Atlantic Alliance (Alliance). In this poster, we will present and describe evolution and status of the SECOORA Data Management and Communication system as well provide examples of data and visualization products available via our web site.

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SPATIAL EXTENT, PATTERNS OF BYCATCH, AND PROBABLE LOSS MECHANISMS OF DERELICT CRAB TRAPS IN TWO ADJACENT SOUTHERN NEW JERSEY ESTUARIES

The Mullica River–Great Bay and Barnegat Bay Estuaries drain >1000 km^2 of New Jersey pinelands habitat while serving as major hubs for multi-use recreational and commercial fishing. From an effort standpoint, blue crab fishers play a major role in both systems (>2,500 traps/year). Unfortunately, the dynamic nature of both estuaries renders a substantial proportion of gear lost each year. To date, no coordinated efforts have been made to fully understand the spatial distribution of derelict pots, patterns of bycatch, and likely mechanisms of pot loss in these neighboring systems. Thus, current project goals revolve around: 1) mapping of potential crab trap targets 2) removal of derelict pots (with concomitant identification of bycatch species and assessment of pot condition) and 3) GIS modeling of frequent gear loss areas. To date, >1700 probable ghost pot targets have been imaged over a total surveyed area of 28 km^2. Using these base maps as guideposts, >550 pots (commercial, recreational) were retrieved during the winter of 2013 via collaborative efforts between commercial crabbers and project scientists (see also "Entry level sonar…." abstract). Preliminary analysis in the lab of bycatch photos taken in the field by commercial crabbers identified macro-organisms found in recovered pots. The top three species, respectively, were Cancer irroratus (rock crab), Opsanus tau (oyster toadfish), and Tautoga onitis (tautog). Probable loss mechanisms of recovered pots were determined based on pot location and condition data. Of the evaluated pots, ~25% were deemed fishable and returned to participating crabbers and the local crabbing community. The estimated total value, including monies for various re-usable parts (re-bar, escape panels) and unfishable pots recycled as scrap, exceeded $6,000.

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IRON OXIDATION IN THE RHIZOSPHERE OF THE WETLANDS PLANTS IS A PHOSPHORUS STARVATION RESPONSE

Phosphorus is the one of the critical elements that is also a frequently limiting macronutrient for plant growth. Since phosphorus is essential for many processes, organisms have evolved various mechanisms and processes that regenerate phosphorus from organic and mineral phases. It is well established that phosphorus starvation stimulates many physiological and morphological changes in a variety of organisms from bacteria to higher plants. We show that phosphorus limitation in some wetland plants leads to an increase in oxidized rhizosphere. One of the classic features of wetland plants is oxidation of the rhizosphere, often visible as rust color deposits on plant roots due to oxidation of reduced iron species in the bulk soil. It is widely believed that this oxidation is a passive result of radial loss of oxygen primarily due to anoxic conditions in wetland soils. Through a combination of micro-array gene expression analyses, and biogeochemical, and physiological experiments we examined the effect of nutrient availability on rhizosphere oxidation in rice plants grown in a hydroponic experimental set up. The results unequivocally demonstrate that iron oxidation was exclusively a result of phosphorus starvation, suggesting that oxidation of rhizosphere is an active process controlled by plants. Phosphorus starvation led to upregulation of several genes in the roots of wetland plants, led to changes in the composition of root wall, as well as resulted in an increased oxygenation of the medium. Due to the reactivity of iron and phosphates, oxidized iron plaque on the roots serve as a strong sink for phosphates from the surrounding bulk soil. Reports suggest that this phosphate is bioavailable to plants. Since this response is also observed in other wetland plants such as Spartina alterniflora, capable of forming oxidized rhizosphere, we suggest that the active regulation of oxidized rhizosphere is another phosphorus acquisition strategy and not a result of anoxia.

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DO SHALLOW-WATER SEDIMENT SYSTEMS CARE ABOUT CLIMATE CHANGE?

Combined effects of warming (4°C over ambient), acidification (-0.35 pH units below ambient) and local stressors (nutrient enrichment and toxicant), and their mode of interaction in shallow-water sediments were studied. Two types of systems were used: bare, natural, undisturbed sediments and assembled eelgrass communities, the latter with manipulated grazer presence. Experiments lasted for 1–1.5 months, allowing both direct and indirect effects. Variables included sediment-–water fluxes of oxygen, alkalinity and nutrients in light and dark, nitrogen mineralization, primary and bacterial production, denitrification, and biomass and composition of organisms. ANOVA, PERMANOVA and Structural Equation Modeling (SEM) statistics were applied. Main findings were: 1) The mode of multiple-stressor interaction varied depending on variable, but was mostly non-additive. Often no significant stressor interactions were found at all. This emphasizes the need of measuring both structural and functional variables. 2) Heterotrophic variables were more sensitive to treatments than autotrophic variables. 3) Dominating autotrophy appears to function as an intrinsic buffer against stressors. Although community respiration and mineralization increase with warming, the benthic photosynthesis can still maintain net autotrophy, adding to the system resilience and retaining the "filter" function of the sediment. 4) Indirect top-down effects of climate change may be as strong, and even stronger, than direct effects, as shown for the eelgrass system. The SEM analyses revealed several strong opposite effects that cancelled each other out, resulting in weak net effects as indicated by ANOVA. Grazers are crucial in mediating these effects and the impact of ocean acidification may be apparent only through indirect effects and in combination with other stressors. These findings emphasize the importance of methods that both separate and quantify direct and indirect effects of multiple stressors.

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VEGETATION DIVERSITY AND NUTRIENT ALLOCATION ALONG A SALINITY GRADIENT EXPERIENCING SEA LEVEL RISE

Estimates suggest relative sea level in the lower Chesapeake Bay tributaries is rising 4-6.8mm/yr. Consequently, intertidal habitats of the Bay's tributaries are susceptible to the increased influx of saline water. We investigated nutrient dynamics and vegetation diversity at four sites along a salinity gradient on the Pamunkey and York Rivers (Virginia, USA): 1) tidal freshwater (Cumberland), 2) transitional oligohaline (two sites within Sweet Hall Marsh (SHM)) and 3) mesohaline (Taskinas Creek). *Spartina alterniflora* has appeared and is expanding its range into part of SHM currently dominated by *Peltandra virginica* and *Zizania aquatica*. Since *Spartina* is generally considered a poor interspecies competitor, we explored the mechanisms behind the recent appearance of *Spartina* through measures of plant diversity, soil and vegetative nutrient content in each marsh. Percent vegetation cover estimated in June and September 2011 captured seasonal changes. Soil and plants tissues were collected monthly June through October 2011 and analyzed for carbon (C), nitrogen (N) and phosphorus (P) content. The results of a Bray-Curtis ordination showed the composition and cover of Taskinas Creek clearly differed from the other marshes. The second axis showed vegetation of north SHM is separating from the cohesive cluster representing south SHM and Cumberland Marsh. Four of the most common species were analyzed for nutrient content, but only *Pontederia cordata* had significantly lower ($p<0.05$) tissue C and N content in the freshwater Cumberland Marsh when compared to south SHM. Carbon and N content in the soils was greatest at Cumberland and significantly different ($p<0.05$) than the other marshes. Soil stoichiometry of SHM was more similar to Taskinas Creek, yet the vegetation similarities were greatest between Cumberland and the SHM sites. This might suggest that soils are responding to changes in salinity driven by sea level rise, with a lag time in vegetative response.

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ASSESSING EFFECTIVENESS OF MANAGEMENT OF A NON-NATIVE PREDATOR IN A COASTAL PROTECTED AREA IN NORTH CAROLINA

Red fox (Vulpes vulpes) are recognized as non-native by resource managers in the southeastern portion of the United States. Sometimes referred to as "subsidized predators," success of this species may be facilitated by its association with humans. In southeastern North Carolina, numerous public and private land management agencies, particularly those managing coastal lands, experienced an increase in red fox activity during the early 2000's. Red fox population expansion has resulted in disruption of sea turtle nesting at several

protected sites, including the Masonboro Island component of the N.C. National Estuarine Research Reserve. An 8.5 mile uninhabited island, protected for research, education, and stewardship, this site is within the nesting range of the Northern Recovery Unity of the Northwest Atlantic population of the loggerhead sea turtle (Caretta caretta). Predation of sea turtle nests at this site increased from zero predation recorded in 1999-2001 to a high of 96% in 2010. Between 2006 and 2012, 57% of nests experienced a red fox predation event. Isolated from the mainland red fox population by water, this narrow, resource-limited site presents an opportunity to assess efficacy of management efforts, examine migration or return rates, and increase understanding of coastal habitat utilization by this predator. Management action was undertaken during the winter of 2013 with the goal of reducing predation of sea turtle eggs to the 10% or below level recommended by the Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle, Second Revision. Removal of three red foxes resulted in reduction of predation to a level of 20% and changed the spatial extent of impacts to sea turtle nests. Post management geographical data provide targeted information to increase efficiency of additional management action.

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MACROALGAE AS BIOCRITERIA: THRESHOLDS OF ADVERSE EFFECTS OF MACROALGAL BLOOMS ON BENTHIC HABITAT QUALITY IN ESTUARINE INTERTIDAL FLATS

In California's Mediterranean estuaries, macroalgal blooms are a common symptom of eutrophication. However, confidence in the use of macroalgae as an indicator of eutrophication, and ultimately its use as biocriteria, is limited by the lack of quantitative data on the thresholds of adverse effects on aquatic life. In the present study, we utilized a combination of field experiments and surveys to identify thresholds of adverse effect of macroalgal biomass on benthic habitat quality in estuarine intertidal flats. Caging experiments were conducted at 4 sites in two estuaries to follow the effect of macroalgal biomass on benthic macroinvertebrate taxonomy, with a range of macroalgal biomass treatments maintained consistently over an 8-week period. Sediment profile imagery was used to document the relationship between macroalgal biomass, sediment organic carbon (%OC) and sediment nitrogen (%N) concentrations on the apparent Redox Potential Discontinuity (aRPD) in a survey of 16 sites in 8 estuaries throughout the State. Results of the caging experiment showed that macroalgal abundances as low as 110-120 g dw m-2 over a 2-4 week period had significant and rapid negative effects on macrobenthic invertebrates. Statistical analysis of field survey data employing the sediment profile camera indicated that 3-15 g dw m-2 were indicative of natural background levels of macroalgae across estuaries. Levels of 175 g dw macroalgae m-2 were identified as thresholds associated with a shallowing of aRPD to near zero depths, an indication of a severe adverse effect on benthic habitat quality. Together, these data, as well as other related studies, represent benchmarks and thresholds along a stress-response gradient. This information is being synthesized into an assessment framework that will serve as the basis for policy decisions by the State of California on regulatory endpoints for macroalgae.

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THE ROLE OF MANGROVE FORESTS IN THE MODERN GEOMORPHIC EVOLUTION OF ESTUARIES

The role of mangrove forests in the geomorphic evolution of estuaries has historically been of considerable scientific interest. In environments remote from terrigenous sediment inputs, mangroves fundamentally influence geomorphology through peat deposition. By contrast, the mangrove forests of continental margins and high islands, such as New Zealand (NZ), are characterised by terrigenous-sediment deposition. In these systems there are conflicting views about the geomorphic role of mangroves. Is mangrove ecology largely driven by physical processes, with colonization of tidal flats occurring once they become ecologically suitable? Alternatively do biophysical feedbacks enhance sedimentation so that mangroves accumulate mud more rapidly than would otherwise occur? Observations over a range of time-scales relevant to sediment dynamics and mangrove biogeomorphology are used to address this question. In the Firth of Thames (NZ) an Avicennia marina mangrove forest has developed on a rapidly accreting mudflat since the 1950s. Data from this site include high-resolution sediment geochronology from cores, surface-elevation dynamics from Rod Surface Elevation Tables (RSET, 2007–) and continuous observations of physical processes driving sediment supply and delivery. Consolidation of the low-permeability muds accumulating in the fringe forest is limited and surface-elevation gains are more similar to sedimentation rates than occurs in old-growth forest near the upper limit of the tide. Rates of surface-elevation gain decline with decreasing hydroperiod and progressive exhaustion of sediment supply with distance from the mudflat. Deep subsidence of the mangrove forest averaging 7 mm/yr is revealed by GPS surveys of RSET and lead-210 dating of cores with relative sea-level rise of ~9 mm/yr being much higher than the eustatic rate. We will argue that mangroves have a limited influence on the geomorphic evolution of estuaries dominated by terrigenous-sediment deposition.

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NET ANTHROPOGENIC NITROGEN INPUTS TO MAJOR INDIAN WATERSHEDS

Simple budget and accounting procedures were among the earliest quantitative methods applied to coastal waters and their watersheds for assessing the magnitudes of material fluxes. Starting in the 1990s, researchers in the SCOPE Nitrogen project began to develop simple accounting approaches for relating nutrient inputs to coastal watersheds to nutrient export to the coast in temperate regions of Europe and North America. A primary aim was to demonstrate the relative importance of anthropogenic nutrient inputs to the riverine fluxes to coastal waters. Population and agricultural census data are used to estimate food/feed, N-fixation and fertilizer components of N inputs; atmospheric depositional inputs are based on model results. Here, we summarize the net anthropogenic nitrogen input (NANI) methodology, and show an application of the approach to Indian watersheds, which are distributed across temperate, subtropical and tropical regions. This preliminary work demonstrates the significant regional variation of anthropogenic N input and its major components across India, and the magnitude of NANI compared to that in regions of Europe and North America.

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THE POWER OF MEASUREMENT: USING INDICATORS TO DESCRIBE THE PAST AND GUIDE FUTURE MANAGEMENT OF FRESHWATER INFLOW TO THE SAN FRANCISCO BAY ESTUARY

Freshwater inflows to the San Francisco Bay estuary have been highly altered by dams and water diversions, and climate change is expected to alter flows further in the future. With competing demands for fresh water, the question of how much inflow is needed to sustain the estuary is the subject of multiple regulatory and planning processes. But answering this question is complicated by large inter-annual variability in hydrological conditions, climate-related changes in precipitation and runoff, and the lack of ecological indicators of inflows that are scientifically defensible and publicly meaningful. We developed a suite of quantitative indicators to measure the amounts, patterns and alterations of inflows to the estuary. Results for recent years show that freshwater inflows have been reduced by more than 50%, high flow events that transport materials and drive ecological processes eliminated in most years, and the quantity and quality of low salinity open water habitat degraded. Inter-annual variability has also been reduced with the frequency of extremely low annual inflow conditions increasing by 350%, effectively subjecting the estuary to chronic drought conditions. In 2012, our multi-metric index of flow alteration fell to its record low. The ecological effects of the degraded inflow conditions are most apparent in the upper estuary: reduced and altered inflows are contributors to native fish declines, increased prevalence of invasive species (and their associated adverse effects on the ecosystem) and toxic algae blooms. There is scientific consensus that improved inflow conditions, including restoration of seasonal and inter-annual variability, are necessary to protect the estuary. The integration of the ecologically important aspects of inflow into simple indicators and indices has proven effective for illustrating the severity of the problem to the public and elected officials and offers a useful tool for designing new regulatory criteria.

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LIGHT AVAILABILITY AND BENTHIC COMMUNITY STRUCTURE IN THE FLORIDA KEYS

Coastal ecosystems are particularly susceptible to anthropogenic impacts because of their proximity to large populations. Consequently, water quality degradation in coastal ecosystems can alter the structure of benthic primary producer communities. In 1996,

parallel monitoring programs commenced in the Florida Keys National Marine Sanctuary (FKNMS) to assess status and trends in benthic community structure (macrophyte richness, abundance), and water quality parameters (turbidity, chlorophyll a, and diffuse light attenuation coefficient (kd)). Chlorophyll a and turbidity were identified as factors limiting the amount of light available to benthic macrophytes, because both factors were positively correlated with the attenuation coefficient ($p=0.0005$ and $p<0.0001$, respectively). Seagrasses in particular have high light requirements. As such, increased light attenuation caused indirectly by elevated nutrient and freshwater input can negatively impact this sensitive system. We calculated percent light reaching the benthos (%Io) across FKNMS using the Lambert-Beer Law [%Io=exp(-1*kd*z)*100]. The light regimes varied in habitats occupied by each of the 4 dominant species of South Florida. Thalassia testudinum, Syringodium filiforme, and Halodule wrightii inhabited sites where %Io averaged 38%-42%. Halophila decipiens and H. engelmanni were identified in sites with %Io averaged 21-30%. We then evaluated the relationship between light availability at depth and benthic community structure to determine if light is a limiting factor in benthic macrophyte growth in the FKNMS. We found spatial but not temporal variation in light availability across FKNMS. The observed results identify regions of FKNMS that could be particularly susceptible to changes in water quality as Everglades restoration progresses.

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EVALUATION OF A BIOGEOCHEMICAL MODEL IN DELAWARE ESTUARY

Estuaries play an important role in carbon cycling and transfer to coastal regions. Dissolved organic matter (DOM) is an imperative component of the organic matter pool and is directly linked to primary production. In an attempt to investigate carbon dynamics in estuaries, a coupled 3D biogeochemical model was configured for Delaware Estuary, with and without DOM. The performance of the two models was compared and influential processes were identified. Our results confirm that the addition of DOM component improves the ability of the model to simulate primary production, mainly by creating a buffer between the particulate organic matter (POM) pool and the bioavailable nutrient pool through solubilization process.

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MONITORING CHANGE IN MIGRATORY WATERBIRD POPULATIONS WITH ESTUARINE TIDAL MARSH RESTORATION: ACCOUNTABILITY, RESPONSIBILITY, AND REALITY

Although San Francisco Bay (SFB) is a highly urbanized estuary, it is renowned for supporting a diverse community of migratory waterbirds. Despite threats from habitat loss, disturbance, fragmentation, invasive species, contaminants, and climate change, SFB ecosystems still support more than a million waterfowl, shorebirds, and seabirds whose communities vary across seasons of the annual cycle. Recent restoration of tidal flows to areas diked or converted to salt evaporation ponds more than a century ago has greatly altered the landscape of SFB habitats. Since the early 1990s, substantial public and private funding has been applied to restore the estuary with a focus on tidal marsh restoration and habitat for endemic and endangered vertebrate populations. Yet, the ecological effects of these restoration projects has been poorly measured, typically through isolated, short-term surveys that end soon after construction is completed and rarely include migratory birds. In nearly all cases, monitoring surveys are not included in initial project support and require independent fund-raising efforts to undertake, resulting in disjointed or inadequate efforts to understand ecological benefits. In addition, few monitoring surveys have comparable data available to compare with ambient conditions if restoration efforts were not undertaken. Here, we discuss results from long-term SFB waterbird surveys conducted in association with large-scale restoration projects in the North Bay (1999-2013) and South Bay (2003-2013). We indicate how integrated monitoring provides accountability for costs, demonstrates responsibility of involved parties, and documents the reality of attempting to restore natural systems in altered environments.

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SEAGRASS RESPONSE TO DIKE REMOVAL, NISQUALLY RIVER DELTA, PUGET SOUND, WASHINGTON

In Fall 2009, several dikes were removed around ~300 ha of marshland in the Nisqually River Delta, Puget Sound, Washington, to restore tidal flows. About 50 ha of eelgrass Zostera marina fringe the seaward edge of the delta. Dike removal was expected to substantially alter land-sea fluxes of water, sediment, and organic material in ways that could impact eelgrass. To understand such changes, water and sediment quality and eelgrass have been monitored annually at a site on the west side of the delta, 1 km seaward of a former dike. A delta-wide hydroacoustic seagrass map was made in February 2012. At the monitoring site, the eelgrass canopy height initially decreased 20% between May 2010 and 2011 and then stabilized at the lower height while shoot densities increased by 25%. Since canopy height is a function of tidal depth, this trend could suggest that bed aggradation occurred after dike removal. In addition, bed sediment generally coarsened and became less reducing. This combination of factors suggests that restoration activities have enhanced sedimentation and altered the character of sediment accumulating at the monitoring site. Anecdotal evidence that eelgrass beds have expanded since restoration can be quantified with repeated hydroacoustic surveys. The trend toward smaller eelgrass shoots has not been matched over four years by a commensurate decline in below-ground biomass, and as a result plants' respiratory carbon demand is expected to be comparatively higher. Eelgrass plants had a highly favorable above-to-below ground biomass ratio of 4 in 2010, and the current ratio of 3 also suggests that plants have a positive net carbon balance. However, this downward trajectory could become an important factor in the long-term sustainability of Nisqually eelgrass beds should the biomass ratio fall below 2.

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BIOGENIC GREENHOUSE GAS FLUXES FROM SEDIMENTS OF AN URBAN WETLAND FRINGING NEWPORT BAY, CA

Urban wetland sediments are saturated by water originating in urbanized watersheds, typically containing a high proportion of impermeable surfaces, as well as permeable landscaping that is irrigated and fertilized. In coastal southern California, groundwater flows from irrigated land continue throughout the dry summer months, delivering fertilizer nutrients to wetlands. During rain events, runoff delivers organic particulates to the wetland. What are the consequences and fates of these allothonous materials within urban wetlands? We measured carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) fluxes from the sediments of Newport Valley Wetland, which drains into. Upper Newport Bay, California, over an annual cycle. We measured gas fluxes using closed chambers at two sites in the wetland with differing vegetation and sediment characteristics. Both CO_2 and CH_4 production was temperature dependent, with the highest fluxes during the summer months. Nitrous oxide production remained below 4 $\mu g\ N_2O\text{-}N\ m^{-2}\ h^{-1}$ during the winter months. Methane production was significantly higher at the *Typha latifolia* site, which was also characterized by higher porewater phosphate concentrations. In contrast, at the *Scirpus spp*. site, sediments consumed CH_4 during the coldest incubations. Gross CH_4 flux in these sediments is the sum of methanogenesis and methane oxidation, with differing temperature sensitivities for each process.

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STABLE ISOTOPES OF NITROGEN IN GREEN TURTLE (*CHELONIA MYDAS*) FROM A FORAGING AREA AT THE MEXICAN CARIBBEAN

Akumal Bay is an important foraging area for juvenile green turtles. Akumal is considered a middle-touristic development in comparison with other surrounding areas. However, tourism activities may be increasing nutrients load toward Akumal Bay. There is limited information about sea turtles function as predator and prey, or conductors of energy/nutrients through the ecosystems. Hence, it is necessary to study sea turtles contribution on these ecosystems. In order to assess the role of green turtles (*Chelonia mydas*) as an indicator of changes in nutrient load, $\delta^{15}N$ was analyzed in green turtles and their potential preys from Akumal Bay. Therefore, $\delta^{15}N$ values from whole blood (WB), plasma and red blood cells (RBC) from green turtles were compared with the values from their feeding source (seagrasses). Green turtles samples were collected in 2012 and 2013, and seagrasses samples were collected from 2011 to 2013. Preliminary results showed that $\delta^{15}N$ isotopic values in *Thalassia testudinum* decreased with time (7.3‰-1.59‰, 2011-2013 respectively). In green turtles tissues, the $\delta^{15}N$ values were 4.82±1.17‰, 5.05±1.25‰ and 5.16±1.18‰ (RBC, plasma and WB, respectively). These results indicate that values in green turtles and seagrass are comparable. Hence, green turtles can reflect N variations as well as the primary producers. There is a significant decreasing in $\delta^{15}N$ values in the last months that may be caused by rain

water inputs from the last year. Nevertheless, some of these values are considered enriched comparing with other sites. This enrichment may be associated to increase of touristic development, thus, it is suggested a continuous monitoring of N in the environment, in order to identify seasonal natural N variation. These results showed that because juvenile green turtle population is resident at the bay can be used as an indicator of N load in the area.

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ANALYZING 190 YEARS OF EXTREME WATER LEVEL ESTIMATES AT NEW YORK HARBOR

Using recently rediscovered archival tide gauge data from 1844-2012, we evaluate the long-term trajectory and causes of NYC flood risk and extreme water levels (EWLs). A bootstrapping technique is used to fill data gaps and produce a 190 yr record of extreme events which includes a category 3 hurricane that struck in 1821. Archival research and a numerical simulation show that the 1821 event produced a larger storm surge than hurricane Sandy, but a lower storm tide (surge + tide). Analysis of the EWLs shows that the upper quartile threshold (the once in four year event threshold) has increased by nearly 30 cm since 1844, rivaling the effect of an approximately 50 cm of relative sea-level rise since 1821. Interannual EWL variability—the difference between the 25th and 75th percentile annual extremes —is correlated to R2 =0.4 with the North-Atlantic Oscillation (NAO) index, with an increased probability of large EWLs occurring during periods of a negative NAO (e.g., the 1960s and 2012 during Sandy). Hence, a statistically significant portion of long-term surge variability—and therefore EWLs and flood risk— are being driven by long-term climatic processes over the Atlantic Ocean. Tidal analysis and numerical modeling suggests that another portion of the increased storm surge risk is due to altered tidal dynamics and non-linear interactions likely caused by increased depth, altered bathymetry, and changed frictional dissipation. Therefore, the lessons learned in the historical tidal record about non-linear tidal distortions in estuaries and the factors affecting them—bathymetry, friction, depth, and river flow —is useful for interpreting storm surge waves and possibly devising mitigation strategies.

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INTEGRATION OF UNDERGRADUATES AND SELECTED HIGH SCHOOL STUDENTS IN LONG TERM WATER QUALITY MONITORING PROGRAM THROUGH DOWLING COLLEGE COOPERATING PARTNERSHIP WITH NATIONAL PARK SERVICE-FIRE ISLAND NATIONAL SEASHORE

The National Park Service (NPS) established Inventory and Monitoring (I&M) protocols to establish a means for understanding the conditions of aquatic resources so that critical questions about long-term trends of degradation, or, about the effectiveness of existing pollution abatement and resource management programs, can be addressed. The Center for Estuarine, Environmental and Coastal Oceans Monitoring at Dowling College (CEECOM), New York has partnered with NPS-Fire Island National Seashore to offer undergraduates and accepted HS students to participate in the ongoing summer Water Quality Monitoring Program. Students get hands on experience collecting samples in the field and processing them in the Water Quality Laboratory. They are also responsible for digital transcription of field sheets and long-term data analysis with faculty supervision. Recently the our Program demonstrated the impact of a “no discharge” policy on the water quality in Great South Bay, Long Island, NY. Upon implementation, average fecal coliform counts over the 13 sites monitored dropped precipitously from 33 to 11 cfu and the number of days exceeding the United States Environmental Protection Agency (EPA) guidelines of 200 cfu fell from 5 to zero.

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CONSERVATION EFFORT TO RESTORE ATLANTIC HORSESHOE CRAB POPULATIONS, *LIMULUS POLYPHEMUS*, AT SPECIFIC SITES DEVASTATED BY COMMERCIAL HARVESTING PRESSURE IN GREAT SOUTH BAY, LONG ISLAND, NEW YORK: RELEASE OF 10,000 CAPTIVELY REARED JUVENILES

Quantitative data collected by the Dowling College Long Island Horseshoe Crab Network (LIHSCN) and anecdotal information from decades of observation of various beaches in Long Island suggest that a decadal decline of spawning adults are site specific and coincide with ease of terrestrial access. Conversely, spawning populations on beaches with limited or no terrestrial access, and on protected beaches with substantial enforcement presence like those in Gateway National Recreation Area where illegal harvest is deterred, or on beaches with limited boat access and keen citizen oversight, like Davis Park and Talisman on Fire Island, remain robust. This may in part be attributed to the only factor known to have a suppressing effect on local populations: commercial harvesting pressure. Annually redundant “none detected” reports for beaches with easy terrestrial and undeterred aquatic access suggest their spawning populations may have been harvested in toto at some point in the past and have not recovered. Genetic identification through haplotypes of local populations and the notion that HSCs exhibit a high level of site fidelity suggest that some barren habitats may not attract immigration of non-native spawning adults despite lower competition for nesting space. The LIHSCN has identified several such sites with acceptable spawning habitat morphological criteria, including narrow width, low wave energy and absence of peat and bulkheads, with no detected spawning populations. Such beaches could benefit from the release of healthy, captively reared juveniles in an effort to repopulate them from their unnatural demise and invigorate the local ecology.

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EMPOWERING UNDERGRADUATE STUDENTS THROUGH PARTICIPATION IN COASTAL RESTORATION

In our aquatic ecology courses (Ecology of Coastal Systems, Limnology, Tropical Biology) we have historically engaged students through lecture/discussion, field trips, hands on laboratories and student designed projects. More recently as our own interests have shifted to understanding human impacts on aquatic ecosystems and restoration, we have involved undergraduate students in every aspect of coastal restoration projects both within traditional courses and through independent study, summer internships, senior research (“St. Mary’s Project”) and volunteerism. Students have participated in monitoring water quality conditions prior to restoration, planning for the project, growing organisms to be restored, construction and/or planting, and monitoring the success of the project. In the process students have worked with state scientists and managers, NGOs, and community members. As a result of their participation in restoration projects, our students feel empowered, gain a greater appreciation for the complexity of coastal ecosystems, and contribute something positive towards reversing human impacts. We will present two examples of restoration projects in the Chesapeake Bay, one on the restoration of an eelgrass bed and the other the construction of 3-dimensional oyster reefs, to illustrate how students are empowered through coastal restoration participation.

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LARGE SCALE NUMERICAL MODELING OF THE LOWER MISSISSIPPI RIVER

Numerical modeling is an excellent way to analyze and understand hydrodynamic properties in changing systems. These models allow for faster set up and analysis than physical models and often cost much less. Typically models are developed for small domains on the order of a few miles of river or a few square miles of area. However, region or system wide impacts due to changes in flow conditions or geometry are often desired to fully understand the effects on the area as well as how small changes may interact with each other. The lower Mississippi River consists of flood plain, levees, dikes, diversions, and marshlands, before entering into the Gulf of Mexico. Approximately 350 miles of the Mississippi River are simulated using the two-dimensional shallow water equations of Adaptive Hydraulics (AdH). The model was run for a three year period to include several high flow events. Vegetative roughness options, wetting and drying features, wind driven flows, and adaptive meshing are all features of AdH that are necessary to reproduce nature. The model setup will be described along with the modeled conditions and model validation results.

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THE IMPACT OF WATERSHED DEVELOPMENT ON TURBIDITY (TSS) IN BAYS WITH CORAL REEFS, US VIRGIN ISLANDS

Coral Reefs in the US Virgin Islands (USVI) are declining partly due to increased land-based sedimentation and turbidity. Watershed development, particularly the building of dirt roads on the high-relief island of St. John, USVI may be contributing elevated turbidity to the near-shore marine waters and fringing coral reefs. Our objectives were to examine how human development and major storms have affected: a) total suspended solids (TSS) (a measure of turbidity), and b) the composition (% inorganic/organic) of suspended solids in marine waters with coral reefs in St. John, USVI. We monitored TSS at eight near-shore and five coral reef sites in Lameshur and Coral Bays every 26 days from 2009-2012 and opportunistically after a storm on the 20th of July 2010. TSS was determined by collecting and filtering 1L bottles of seawater onto pre-weighed filters (Whatman GFF, 1.5 μm pore size) that were dried and weighed to calculate TSS (mg/L). The filtered suspended solids were then burned at 550 deg. C to determine the % residual inorganic matter. Measurements of TSS at 26-day intervals were highly variable but generally low (<10 mg/L) except following major storm events or periods of high wave energy. TSS and the % inorganic matter in the suspended solids were greater below the developed compared to undeveloped watersheds. Mean seasonal TSS was greater in 2010 than the other 3 years (2009, 2011 and 2012) due to the unusual frequency and magnitude of storms. Following a major storm

in 2010, TSS measurements between 110 and 400 mg/L (and up to 187 times greater than measured during fair-weather periods) were recorded. These data will provide a baseline for future research, which will evaluate whether watershed restoration projects implemented in 2011 to reduce land-based sedimentation have measurably reduced turbidity in Coral Bay, St. John.

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TIDES AND TIDAL CURRENTS IN A COASTAL LAGOON OF THE GULF OF MEXICO

Chelem lagoon is a shallow body of water located in the coastal belt of the peninsula of Yucatan. Tides and the vertical structure of the flows at the entrance to the Chelem lagoon are examined using a 63-day bottom-mounted Aquadopp and three pressure sensors, one located near to the Aquadoop and the other two in the inner part of the lagoon. Harmonic analysis techniques are used to extract tidal constituents from the sea surface elevation time series and tidal ellipse parameters from the velocity time series. At Chelem lagoon entrance the most energetic constituents are K1 and O1 with elevation amplitudes of 17.6 ±1.4 cm and 17.4 ±1.8 cm, respectively. Furthermore, the semidiurnal tide with the largest amplitude is M2 with 5.7 ±0.4 cm. The form number is ~5 in all the observational sites, which implies that the tide in the lagoon is diurnal. Results indicate that shallow water tides are not significant in the mouth of the lagoon and that they are generated in the inner part of the lagoon. Based on amplitudes and phases of the semidiurnal and quarter-diurnal tides it is found that Chelem lagoon is an ebb-dominated system. Tidal currents are also calculated, the most important constituents are K1-current and O1-current with velocity amplitudes of 26.1 ± 2.1 cm/s and 23.1 ± 2.4 cm/s, respectively, and M2-current with velocity amplitude of 12 cm/s ± 0.8. The tidal excursion is ~ 8 km for the O1 tide and ~2 km for the M2 tide. Using tides and tidal currents information it is found that tidal flow characteristics in the channel is a mixing of standing and progressive waves. The vertical structure of the mean velocity at the entrance to the lagoon revealed three layers: two of them are inflows, in the surface and in the bottom layers, and the other one is an outflow at 3 m depth near to surface layer, which suggests that there is a current in the middle of the channel presumably driven by a density gradient.

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HYPOXIA AND NUTRIENT CYCLING IN COASTAL ECOSYSTEMS: INSIGHTS GAINED FROM INTEGRATING OBSERVATIONS, RETROSPECTIVE ANALYSIS, AND NUMERICAL MODELING

Hypoxia, or the condition of low dissolved oxygen concentration, is an important feature of many coastal ecosystems. Hypoxia is most often associated with negative impacts on several components of the food web, but low oxygen also has considerable impacts on the cycling of many important elements in both sediments and the water-column. Hypoxia has been hypothesized to be a self-reinforcing phenomenon, as elevated nitrogen and phosphorus recycling under low oxygen conditions could support additional phytoplankton growth and subsequent oxygen consumption. The testing of such a hypothesis is not necessarily straightforward, as it requires an understanding and analysis of the synergy among sediment biogeochemical processes, phytoplankton dynamics, and hydrodynamic variability. Thus, we completed a synthesis of observations, retrospective data analysis, and numerical modeling studies to understand feedbacks between hypoxia and nutrient cycling at the ecosystem scale in a large estuary (Chesapeake Bay). Our analysis suggests that connections between hypoxia and nutrient cycling are regionally-and seasonally-dependent, which may influence the potential for hypoxia to be self-reinforcing over decadal scales. These analyses underscore how feedbacks must be considered in coastal ecosystem management and how the integration of varied tools and datasets yields unique insights into coastal processes.

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MARRYING MODELS AND DATA: ADVENTURES IN MODELING, DATA WRANGLING AND SOFTWARE DESIGN

The objective of this research is to develop an open source tool that merges model output with field observations for fast and efficient model validation. Our tools are useful for enhancing 3D circulation models, biogeochemical models, oil spill response models and environmental impact statements that put into place response and mitigation plans before events such as spills occur. We use the Lagrangian TRANSport (LTRANS) model to simulate the fate and transport of oil from the DeepWater Horizon (DWH) event. The observations of hydrocarbons during and after DWH are vast, heterogeneous and distributed. This project required collection and integration of existing data into a single relational database, development of novel code modules for comparing this data to model output and development of visualization tools written in the Python programming language. In addition to the databases available through the National Ocean Data Center (NODC) and NOAA Natural Resource Damage Assessment (NRDA) Process, we are also using data from single investigator studies. To date, 100 of these single-investigator data sets have been identified and contact has been initiated to obtain 93 of them. Only 35% of the investigators contacted responded and only 10% of investigators have actually shared data. Despite low participation, the database contains over 2 million data points from oceanographic and hydrocarbon measurements, including hydrocarbons in the air, sediments and biota. These data are held in an SQL database and queried using novel “nearest-neighbor” algorithms for comparison with LTRANS output. This talk will present the database structure, workflows, data integration issues and solutions, visualizations and current performance metrics for LTRANS.

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20% MORE EELGRASS IN PUGET SOUND BY 2020: RESTORATION SITE SELECTION

As part of a larger program by the state of Washington to restore the Puget Sound ecosystem, we are engaged in a selection process to locate specific areas where eelgrass could be restored or enhanced to meet the goal of 20% more eelgrass by 2020, amounting to a ~4,000 ha increase in areal eelgrass coverage. Embedded in this goal is the establishment and development of meadows that are resilient to the effects of climate change and anthropogenic and natural disturbances. We hypothesize that: (1) many sites are recruitment limited; (2) eelgrass has been lost in some areas because of temporary disturbance; and (3) there may be broader stresses limiting eelgrass in subregions of Puget Sound. Our approach utilizes an understanding of eelgrass growth requirements coupled with hydrodynamic and water quality models, an eelgrass growth model, field observations, and test plantings. We are using these results along with spatial data and stressor information collected as part of regional assessments of nearshore ecosystem condition to identify restoration sites. We are also working with local governments to determine actions that could be taken to improve conditions for eelgrass within their jurisdictions to maximize the success and long-term viability of planted meadows. The models revealed differences in the predicted growth rate of eelgrass among regions. In general, northern Puget Sound and Strait of Juan de Fuca provided the best conditions, whereas Hood Canal and southern Puget Sound were relatively less suitable for eelgrass. Field visits were conducted at 23 sites where the eelgrass model predicted good growing conditions but where eelgrass does not presently exist based on available information. From among these sites we selected five sites for test planting. Test plantings, modeling and jurisdictional information will form the basis to develop strategies for larger recovery efforts.

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WAVE-CURRENT BOUNDARY LAYER INTERACTIONS WITHIN A *ZOSTERA MARINA* SEAGRASS BED

Wave motion can interact with the sea floor in shallow coastal areas, including many regions dominated by submerged aquatic vegetation. In combined wave-current flow, bed shear stress is governed by wave boundary layer dynamics within a thin layer adjacent to the sediment-water interface. Stresses exceeding a critical shear stress can locally suspend

sediment, attenuating light necessary for the survival of aquatic plants. Within a shallow Virginia coastal bay vegetated by Zostera marina, high resolution velocity profiles were collected in 1 mm increments spanning a three centimeter vertical profile adjacent to the sea floor using a Nortek Vectrino II acoustic Doppler profiler. Similar profiles were collected at an adjacent bare site. At the bare location in wave dominated conditions, we observed two distinct logarithmic layers, a high-stress wave boundary layer typically between 10-20 mm in thickness, superimposed over a second log-layer extending to the top of the three centimeter profiler range. In low wave conditions, a single logarithmic layer formed due to tidal currents. At the vegetated site, more complex dynamics obscured the expected logarithmic profiles. Turbulence structure and stress distributions near the sediment-water interface were quantified after wave-turbulence decomposition was performed and compared between the two sites to assess the influence of seagrass on boundary layer processes. Reduced wave activity and shear stress within the seagrass bed correlated to reductions in sediment suspension as compared to the unvegetated site.

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FRESHWATER MUSSEL DIVERSITY AND ABUNDANCE VERSUS DEPTH IN THE TIDAL DELAWARE ESTUARY

Unionids are an important component of freshwater ecosystems and are key indicator species of habitat integrity, water quality and substrate stability. Until recently, it was believed that there were few mussels remaining in the lower Delaware River Basin, but mussel surveys conducted between 2010-2013 have revealed sizeable and diverse populations in the tidal freshwater portion of the estuary. For protection and restoration reasons, it is important to ascertain the parameters that govern suitable habitat for these important natural resources. In summer of 2012, quantitative mussel surveys were completed at representative locations along a sixteen-mile stretch of the tidal Delaware River between Trenton, NJ and Philadelphia, PA. Snorkeling efforts identified the presence of six mussel species. Eastern Elliptio (Elliptio complanata) and Eastern Floater (Pyganodon cataracta) were the most common species but rare Eastern Pondmussels (Ligumia nasuta) and many Tidewater Muckets (Leptodea ochracea) were also collected. Mussel densities increased significantly with depth at most sites, but not for all species. Species richness was more variable among sites than with depth. Additional surveys conducted using SCUBA and benthic samplers in deeper waters revealed the presence of significant mussel resources at depths up to 10m. We conclude that depth is an important feature for governing mussel population abundance. Since the Delaware Estuary has one of the largest freshwater tidal zones in the world, these bivalve populations appear to be ecologically significant resources that merit careful management and protection. Many sites that appeared suitable for mussels were not colonized, however, and so there is potential for enhancement of these areas to boost mussel carrying capacity. Knowledge of mussel affinities for different depths, velocities and substrates will facilitate restoration designed to maximize system resilience and ecosystem services.

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RAMAN SPECTROSCOPY AS A TECHNIQUE TO STUDY BIVALVE LARVAE

In order to study the dispersal of bivalve larvae, it is crucial to be able to identify them to species. Raman spectroscopy is a non-invasive, non-destructive analysis tool that can provide information about the structural makeup of various materials. For bivalves, Raman analysis reveals pigments present within the aragonite shells that reveal distinct spectra between species. We are investigating the use of this technique to (1) identify bivalve larvae to species, (2) possibly determine larval origins, and (3) compare to other methods for bivalve larval identification like image analysis. This work has revealed that spectra can be used to distinguish larval species with up to 100% accuracy and certain species may also demonstrate different spectra in early shells that may be associated with larval origins. The high accuracy of this technique makes it a promising way to ground-truth other methods for identifying bivalve larvae from field samples, and new analysis techniques are currently in development.

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HITCHHIKERS GUIDE TO SHIPPING – VESSEL TRAFFIC AND THEIR NONINDIGENOUS SPECIES MANAGEMENT PRACTICES AT SOUTHERN CALIFORNIA PORTS

Nonindigenous species (NIS) are organisms introduced through human activities to an area where they do not naturally or historically occur. Once established, NIS can have ecological, economic, and human health impacts on the receiving environment. The coastal waters of California are some of the most invaded areas of North America (NA), roughly 89% of western North America's currently established marine NIS were first documented in California. In coastal environments, the commercial shipping pathway has contributed up to 79.5% of NIS introductions to North America and 81% in California. Commercial vessels transport organisms through two primary vectors: ballast water and biofouling. The California State Lands Commission's Marine Invasive Species Program (MISP) is responsible for preventing or minimizing the release of NIS from vessels that are 300 gross registered tons and above. In order to assess the likelihood for vessels to introduce NIS into California waters and/or spread NIS to other areas, an examination and analysis of vessels' NIS management practices and their previous and subsequent ports of call was conducted for the ten recognized commercial port zones in northern California. This study examines the ballast water and biofouling management practices of the vessels arriving in southern California. For example, 14% of these vessel arrivals discharged ballast water into California waters. Understanding ballast water and biofouling management patterns and the movement of vessels can inform risk management strategies to decrease the introduction, establishment, and spread of NIS.

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INVESTIGATING RAINFALL AS THE DRIVER OF PHYTOPLANKTON RESPONSES TO CLIMATE VARIABILITY

Climate variability influences most of the important environmental drivers such as temperature, wind, salinity, sea level, sea state, sea ice, currents, rainfall, river flow, residence time and many of these have significant interactions with the impacts of rising atmospheric and oceanic CO2 concentrations. In this study we investigate the impacts of variability in rainfall, river flow and residence time on phytoplankton biomass and community composition. The study draws upon long term data sets from three different types of aquatic ecosystems: rivers, estuaries and the coastal ocean. Case studies have shown that along the continental shelf higher rainfall was often associated with increase nutrient loading especially silicate. The phytoplankton communities on the shelf had increased proportions of neoxanthin, prasinoxanthin and chlorophyll b indicating more Chlorophytes and Euglenophytes during periods of higher rainfall. Low rainfall was associated with longer residence times in some estuaries and an increased proportion of dinoflagellates relative to diatoms. Annual nutrient loading and mean annual phytoplankton biomass in some estuaries was also a positive function of mean annual rainfall. We use a simple approach to investigate the generality of these relationships across many ecosystems by comparing the anomalies in local rainfall with anomalies in phytoplankton biomass and composition from a range of long term time series sites.

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RAPID DIEBACK OF THE FOUNDATIONAL TEMPERATE SEAGRASS *AMPHIBOLIS ANTARCTICA* IN A TEMPERATE-TROPICAL TRANSITION ZONE FOLLOWING A HEAT WAVE

Marine ecosystems where habitat-forming species exist near their thermal tolerance limits are prone to temperature-related perturbations that cause dramatic shifts in community structure and function. In a global biodiversity hotspot in Western Australia, at the transition between temperate and tropical zones, we documented the rapid decline of the foundational, temperate seagrass Amphibolis antarctica following a 2011 marine heat wave during which summer temperatures were ca. 2-4°C above long-term averages for over two months. Median percent cover of A. antarctica at 113 sites declined from 83.4% before the heat wave (2007-2009) to just 1.7% afterward (2012). Animal-borne video taken from marine turtles that forage in A. antarctica beds also revealed dramatically poorer seagrass condition in late 2011-2012 compared to a decade earlier. This response to a positive temperature anomaly may mark a rapid phase shift toward more tropical species characterized by lower habitat value, or portend a longer-term trend in that direction, consistent with predictions of the tropicalization of this region. The loss of ecosystem services from the decline of structurally complex temperate seagrasses in low-latitude coastal ecosystems may be severe.

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UNDERSTANDING HOW CLIMATE CHANGE AND STORM EVENTS CAN AFFECT SALT MARSH WILDLIFE

Coastal salt marshes are projected to be disproportionately impacted by climate change, including sea-level rise and changes in storm frequency and intensity. Storm events will affect salt marshes by altering inundation duration and depth, changing suspended sediment supply and habitat availability for terrestrial wildlife. Although the San Francisco Bay Estuary is severely fragmented and modified, it is one of the largest tidal salt marsh complexes in California and contains important habitat for federal and state-listed wildlife species. The maintenance and expansion of habitat is crucial to the successful recovery of these wildlife species, but it remains unknown how storm flooding may impact populations. Two studies were done using site-level water monitoring to assess storm impacts to marsh wildlife and available habitat. During the California black rail (Laterallus jamaicensis coturniculus) 2006 breeding season a storm event occurred, which resulted in prolonged inundation of home ranges. Population viability modeling indicated that with increased storms, their numbers would decrease as much as 52% by mid-century. In addition, two local storm surges were recorded in 2010 and 2011 at three salt marshes. Duration of marsh inundation during the storm episodes was respectively 1.8 and 3.1 times more than normal for that time of year. At peak storm surge, over 65% in 2010 and 93% in 2011 of the available habitat for wildlife was under water, increasing predation and drowning risk. Sea-level rise and increases in storm frequency and intensity will have conservation implications for salt marsh wildlife and their habitats.

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HOW DO TRANSPLANT SOURCE AND RESTORATION SITE CONSTRAINTS INTERACT IN REINTRODUCTION EFFORTS OF NATIVE PACIFIC CORDGRASS (*SPARTINA FOLIOSA*) IN THE SAN FRANCISCO BAY?

Large-scale planting of Pacific cordgrass, *Spartina foliosa*, has been initiated in San Francisco Bay for the first time since the 1970s. This project seeks to reestablish native cordgrass to regions where a highly invasive hybrid (*S. alterniflora x S. foliosa*) had established, but has since been removed. Restoration is now complicated by a paucity of native cordgrass populations available for transplant and altered marsh characteristics following hybrid invasion, as well as the potential for grazing damage by Canada Geese. In 2011, we explored the relationship between restoration site characteristics, parental source of *S. foliosa* transplants, and plant caging. We transplanted plugs from 4 donor marshes into 5 restoration sites, pairing caged and uncaged material, and monitoring growth responses monthly. After one year, it was clear that herbivory pressure varies greatly between restoration marshes. Marshes with resident geese had low survivorship of uncaged plots (<7%), but caged plots had high survivorship (>75%). In marshes with limited grazing pressure, caging did not hinder survivorship, but did decrease plant performance. The source of transplants had strong effects within some of the restoration sites. In 2012-2013, we further explored the interaction between source of transplant material and edaphic conditions. Plants were collected from 8 widespread marshes, genetically tested using microsatellites, and grown in identical nursery conditions. Despite detection of little population structure among sources, they differed greatly in growth characteristics in the nursery after 10 months. Preliminary monitoring after planting in the field further suggests that the source of transplant material strongly influences survivorship, although this was not predictable from patterns in the nursery beds. We conclude that both goose exclusion and transplant source selection should play an important role in ongoing *S. foliosa* restoration.

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INTEGRATING CAUSAL AND EXPLORATORY TECHNIQUES TO INDICATE THRESHOLD POTENTIALS IN REAL WORLD ECOSYSTEM DYNAMICS

Thresholds or tipping points profoundly affect our understanding of ecosystems dynamics and the nature of advice we should offer managers and policy makers. Although theoretical studies of such complex dynamics in ecological systems has advanced rapidly, confidence in the existence of threshold dynamics in nature is often hampered by a lack of empirical evidence. Nevertheless, regime shifts have been documented in estuarine and coastal ecosystems and the mechanisms behind these shifts have been illuminated with hindsight. The search for signs that a particular systems may be prone to threshold shifts before it happens remains a significant challenge. Complex-system theory highlights the importance of positive feedbacks in interaction networks in maintaining resilience. Here we describe the results of a manipulative field experiment designed to test how changes in environmental conditions can change the typology of interactions networks in soft-sediment ecosystems. Our experiment was designed to assess the effect of reduced light levels, as a surrogate for elevated suspended sediment concentration, on the interactions between large bivalves (Macomona liliana and Austrovenus stuchburyi), microphytobenthos and sediment particle size. Using structured equation modelling to define differences in interaction networks we were able to demonstrate that experimental shading of the sediment surface over 3 months strongly reduced positive feedbacks. These experimental results are generally consistent with broad-scale survey data that reveal changes in interactions networks can occur abruptly along environmental gradients. This approach highlights the potential to more precisely define the risk of threshold shifts in ecosystems associated with changes in stressors if we understand ecosystem function.

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RESPONSE OF NUTRIENT EXPORTS TO CHANGES IN LOADINGS FROM DIFFERENT SOURCES ON THE CHESAPEAKE BAY WATERSHED

Hypoxia is a recurring event in summer in the Chesapeake Bay, causing millions fish dead each year. With a 166,000 km2 watershed and a land-to-water ratio up to 2600, understanding nutrient dynamics in the watershed is the key to control nutrient loadings to and ultimately restoring the Bay. Using the HSPF watershed model, we did a detailed analysis on nutrient exports to changes in nutrient loadings in the Chesapeake Bay watershed. The watershed is divided in to 368 land segments. Atmospheric deposition, manure, fertilizer and nitrogen fixation are the major sources of nutrient loadings. Nutrient uptake based on yield is also included in the analysis. Thirty land-uses are characterized and parameterized in the model, including 25 pervious land-uses and 5 impervious land-uses. We selected 14 scenarios from the EPA archived simulations to analyze the response (or sensitivity) of nutrient exports from each land segment to changes in the nutrient loadings from the aforementioned various sources. These scenarios were thus selected to cover a wide range of different nutrient inputs including some of the extreme scenarios. The results show that linear relationships between input and output dominate over a vast region of the watershed. The sensitivity of nutrient exports to changes in nutrient loadings differs for

different nutrient loadings and land uses. Among the land uses, forest and pasture have the lowest nutrient export sensitivity to changes in nutrient loadings whereas high-tillage cropland without manure has the highest responses in nutrient exports. Among the different sources, atmospheric deposition results in more rapid response in nutrient exports whereas legume fixation has the slowest response. However, the relatively sensitivity of different nutrient loadings changes over land uses as well. More detailed and comprehensive analyses will be presented at the forthcoming conference.

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FLATS ECOSYSTEMS AS AN OUTDOOR CLASSROOM: UNDERGRADUATE CONTRIBUTIONS TO BONEFISH RESEARCH IN THE BAHAMAS

Tropical and subtropical flats in The Bahamas provide a range of ecosystem services and critical habitat for a diversity of fish and invertebrates and support important fisheries. Anglers from around the world travel to The Bahamas to fish the flats. A recent study of the importance of recreational flats fishing to the Bahamian economy revealed that flats fishing generates $141 million annually and the revenues generated through bonefishing (Albula spp.) related tourism form the economic basis of entire local communities. However, despite their economic importance, until recently, relatively little was known about the biology and ecology of bonefish making conservation and management of the species difficult. The Cape Eleuthera Institute's (CEI) Flats Ecology and Conservation Program connects primary research with education and outreach in an integrated approach designed to better understand flats ecology. Each January since 2007, Monmouth University undergraduates in the Tropical Island Ecology course have worked side-by-side with scientists at CEI assisting them with their suite of research on bonefish ecology and behavior, including investigations of the age structure of local bonefish populations, growth rates and environmental factors affecting growth rates; the spatial ecology of bonefish; when and where bonefish spawn; habitat requirements and important nursery areas for juvenile bonefish; and bonefish feeding ecology. Collectively, this experiential education opportunity provides undergraduates with a hands-on learning-based approach where they are fully immersed in applying what they learn about in the classroom in an authentic science application. This fosters a better understanding of complex ecological interrelationships and processes that are often difficult to conceptualize in a traditional classroom setting and allows the students to achieve a greater appreciation for the types of research necessary to inform conservation and management decisions.

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SHELL MIDDENS AS INDICATORS OF FISHING PRESSURE ON THE QUEEN CONCH RESOURCE IN SOUTH ELEUTHERA, THE BAHAMAS

The queen conch (Strombus gigas) is one of the most important fishery resources in the wider Caribbean. However, there is concern that conch stocks are overfished throughout the region and therefore vulnerable to collapse. Fisheries regulations in The Bahamas attempt to address this by prohibiting harvest or possession of juvenile conch. In south Eleuthera the conch fishery consists of a small scale commercial harvest supplying fresh conch to local restaurants and a subsistence fishery. Fishermen land conch in close proximity to their fishing grounds to remove the meat and deposit the shells in large midden piles along the shore. Assessments of the age distribution of conch exploited from local populations are possible by measuring and observing the characteristics of shells in conch middens, as adult conch can be distinguished from juveniles by the presence of a well formed flared lip. Researchers have used this method throughout the species range as an indicator of the effects of fishing pressure on conch populations. Since 2007, we have conducted surveys of a number of abandoned and active conch middens around Cape Eleuthera to determine whether the age or mean size of conch being harvested has changed over time. Our data indicate that the conch harvest has changed from a fishery dominated by mature adults to a fishery dominated by juveniles and subadults. In addition, the mean size of conch being harvested has decreased by approximately 10% during this time period. The higher proportion of juvenile and subadult conch in the middens suggests that adult conch are becoming scarcer. This presents a dilemma for communities that rely on the local conch fishery and requires an adjusted management response by the Bahamian government. While strict enforcement of current regulations is an option, the future of local conch populations may be enhanced by creation of a series marine protected areas that include conch nursery grounds and establish spawner sanctuaries.

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WHAT ONE MILLION FISH CAN TELL US ABOUT THE SOUTH SAN FRANCISCO ESTUARY

The Marine Science Institute (MSI) in Redwood City, California is a non-profit educational institution that instructs participants in the ecology and conservation of the San Francisco Estuary (SFE) through experiential learning programs. Daily field trips in the southern SFE aboard an oceanographic research vessel form the core of MSI's curriculum. Three or four fish trawls are conducted each voyage, and trained fish interns collect data on the fish caught in each otter trawl net tow. Fish are identified to species, the standard length is recorded, and individuals of the same species are grouped into size classes and counted. We have collected data from more than one million fish from nearly 10,000 trawls since MSI's founding in 1970. Our initial discoveries include a slight increase in total fish catch per trawl and fluctuations in the diversity of more than 130 species recorded. We found a significant negative correlation between Northern anchovy and Shannon's diversity index. Our records reflect the Pelagic Organism Decline (POD) from 2001-2009, well documented in the northern reaches of the SFE.

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MODELLING VARIABILITY PATTERNS OF SUSPENDED SEDIMENT AND PRIMARY PRODUCTION IN A SHALLOW COASTAL LAKE SYSTEM USING A COUPLED BIO-PHYSICAL MODEL

Lake St. Lucia is one of Africa's largest estuarine lakes and is part of the iSimangaliso Wetland Park, a UNESCO World Heritage site. The system is an important source of biodiversity and plays an important role as a nursery ground for fish and prawn which are sustained by a diverse and productive planktonic and benthic food-web. The lake system experiences generally high levels of suspended sediments due to wind driven re-suspension of sediment. Field measurements showed that suspended solid (TSS) concentration increases immediately after waves built up driven by wind. TSS concentration can increase from 10 mg/L to more than 100 mg/L within hours. In addition to this short-term variability, seasons differ in wind intensity with the summer months being more windy than the winter months. Different sediment characteristics and water depths throughout the lake system can cause spatial heterogeneity in suspended sediment concentrations. The high temporal and spatial variability in suspended sediment has implications for primary production in the system, since they result in highly variable light availability. Light attenuation can vary by a factor of 10 over one day. We model wind driven waves and sediment resuspension with a hydrodynamic spatially explicit model of Lake St. Lucia and couple it with a model of microalgal dynamics using the model environment Mike21 (Danish Hydraulic Institute). Using such a coupled spatially explicit model approach we aim to investigate the effects of variability in sediment resuspension on microalgal dynamics at different scales in Lake St. Lucia.

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ASSESSING THE EXTENT, CAUSES AND POSSIBLE REMEDIES FOR EUTROPHICATION IN THE MIDDLE EAST - POTENTIAL APPLICATION OF TECHNIQUES USED IN THE US AND ELSEWHERE

Like Florida in the 1960s to the early 1980s, the natural communities of the coastal waters of the Arabian Peninsula are experiencing degradation from both direct and indirect impacts. Massive coastal developments have impacted productive resources through dredge and fill activities, and altered shorelines have sometimes created dead-end canals in previously well-flushed locations. Rapid economic growth has brought with it an increase in population, with the result that many regions are adversely impacted by effluent disposal from overwhelmed wastewater treatment facilities. In some locations, the construction of skyscrapers has required dewatering of nutrient-enriched and saline surficial aquifers into coastal waters, a problem more complex to address than that of wastewater treatment alone. Successfully responding to these problems requires a thorough understanding of the extent, causes and potential remedies available. An approach that builds off of the actions behind successful restoration efforts worldwide will be discussed, and potential management pathways will be compared.

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THE BIG SQUEEZE: CALIFORNIA COASTAL LAGOONS AND SEA LEVEL RISE

The coast of California is dotted with hundreds of small seasonal estuaries, frequently referred to as "lagoons," that serve as the outlets for coastal watersheds. These lagoons tend to be highly dynamic habitats that in many locations fluctuate between drained, intertidal, brackish conditions in winter (when the outlet is open to the ocean) to flooded, supratidal, freshwater conditions in summer (when the outlet is closed). These unique characteristics make lagoons particularly valuable habitat for a broad range of listed species, including steelhead, coho salmon, tidewater goby, California red-legged frog, and western pond turtle. In urban areas, the lagoons and their associated beaches and floodplains are often the location of critical infrastructure such as wastewater treatment plants, highways, and residential/commercial centers. The often-competing management objectives of habitat protection and flood risk reduction will only become more difficult to reconcile as sea levels rise and lagoons are either squeezed between the ocean and uplands, or are allowed to transgress over upland habitats. Our discussion will present an overview of lagoon morphodynamics, describe likely impacts to lagoon habitats and flood risk due to sea level rise, and summarize the tools that will be necessary to understand, manage, and enhance these systems in the future.

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DENITRIFICATION WITHIN DRIFTING MATS OF *GRACICLARIA VERMICULOPHYLLA*

Gracilaria vermiculophylla is a hardy, fast growing rhodophyte native to the coastal Northwest Pacific. It has recently become established as an exotic species along the coasts of North America as well as western Europe. In shallow, low-energy bays and lagoons, *G.vermiculophylla* invasions may result in transformation of soft-bottom and seagrass beds into an new "Gracilaria meadow" habitat. Dense aggregations of *G.vermiculophylla* fragments can increase light limitation, create heavy wrack lines, and cause hypoxia. Drifting fragments of the macroalgae frequently aggregate into dense mats, providing substrate and stabilizing the near-benthic water column. These conditions facilitate a strong oxic/anoxic gradient from the exterior to the interior of the mats. Dissolved oxygen may range from >25mg/L along the exterior from photosynthesis, to <0.1mg/L only a few centimeters within the mats due to respiration. This strong O_2 gradient is likely to be conducive for coupled microbial nitrification/denitrification. Rates of denitrification and anammox were measured along the extremities and deep within algal mats using 15N tracer incubation experiments. Preliminary results suggest that increased coupled nitrification/denitrification may be occurring at significant rates within these mats. *G.vermiculophylla* has been reported to make up >80% of macrophyte biomass where it becomes established, and changes in nitrogen flux within macroalgal mats may be significant in affected areas. Current work seeks to identify impacts of *G.vermiculophylla* on nutrient cycling as well as potential management and mitigation approaches.

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SEA LEVEL OBSERVATIONS FOR UNDERSTANDING COASTAL MARINE ECOLOGICAL CHANGE THROUGH NETWORKED SENTINEL INSTRUMENTATION - THE SMITHSONIAN TENNENBAUM MARINE OBSERVATORIES

The Smithsonian Institution (SI) Tennenbaum Marine Observatory Network (TMON) is envisioned as an integrated global network of sites dedicated to explaining and forecasting effects of global change and anthropogenic impacts on ecological structure, function and biodiversity. To provide a physical environmental framework and context for biodiversity research across TMON's latitudinal range, SI is establishing a robust system of tide gauges, terrestrial geodetic control networks, real-time communications, data analysis protocols and database system modeled on NOAA/NERRS Sentinel Site protocols (SSP) and the Global Sea Level Observing System (GLOSS). This effort is improving data being collected at existing SI field stations in Maryland, Florida, Belize and Panama. The geospatial infrastructure at SI's Caribbean laboratories will anchor a pan-Caribbean Sentinel Site network, providing long-term observations for understanding sea level rise effects on ecosystems. Presently the Belize station has maintained the only continuously operating tide gauge in much of the western Caribbean, with a 14 year time series. SI's developing sentinel sea level site at STRI's Bocas del Toro Laboratory, Panama, includes a stable marine instrument platform, GLOSS-standard radar and pressure sensor tide gauges, tide switches, GOES communications and a geodetic control network. SI plans to achieve the goals of TMON partly through partnerships with other institutions. For example, the Panama Sentinel Site was installed in collaboration with NOAA-NGS, with an additional investment by UNAVCO, Inc. of a COCONet continuous GPS station to monitor vertical change over time. The SI-NOAA collaboration has installed sea level observing infrastructure at SI's research areas in the Belize Barrier Reef and the Chesapeake Bay in Maryland, and will soon expand to include the Indian River Lagoon in Florida. Additional network sites inside and outside the United States are currently under consideration.

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SPATIOTEMPORAL PATTERNS OF NATIVE AND INVASIVE ASCIDIAN ASSEMBLAGES IN MISSION BAY, SAN DIEGO, CA, USA

Spatial and temporal patterns of ascidian community assemblages were examined within fouling communities of Mission Bay, San Diego, California, USA. We hypothesized that ascidian communities would be structured by spatial differences in environmental parameters between sampling locations. Settlement patterns of native and invasive ascidian species were monitored weekly from September 2011 through November 2012 using settlement plates deployed on floating docks at four sampling locations. Environmental parameters (temperature, salinity, visibility and DO) were measured concurrently. In total, eleven of the fifteen ascidian species observed on settlement plates were invasive species. Sampling locations within the bay differed significantly in ascidian community composition and spatial differences in visibility, salinity, and temperature were correlated to community dissimilarity. Additionally, we observed seasonal persistence of invasive ascidians; below average rainfall in a region of mild climate likely prevented winter cessation. As such, a shifting global climate may be advantageous to invasive species, not only with regard to mediating their persistence, but also in terms of facilitating the establishment, spread, and dominance of future invaders.

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PHYTOFLASH™ ACTIVE FLUORESCENCE PROBE: APPLICATIONS IN A TURBID ESTUARY, SAN FRANCISCO BAY, CA

Measures of phytoplankton standing stock and activity are critical for the study of estuarine food webs. The measures generally rely on discrete sampling methods, which limit spatial and temporal habitat coverage, and can be relatively costly and time consuming. An alternative measure of phytoplankton physiology in situ utilizes natural fluorescence emission from chlorophyll, which can vary in response to environmental conditions such as light and nutrient levels. Active fluorescence probes use controlled light pulses to investigate the efficiency of electron flow through PSII, a useful indicator of algal health. Active fluorescence measurements have been used to investigate photosynthetic function in plants, oceanic phytoplankton and cultured phytoplankton. Relatively little work has tested the application of bio-optical fluorescence probes in estuaries. This study involves testing the capabilities of the PhytoFlash™ active fluorometer (Turner Designs) for investigating phytoplankton physiology in situ in the turbid San Francisco Estuary. The PhytoFlash™ can be deployed from boats or moorings, and monitor field phytoplankton assemblages continuously and in real time. A series of experiments were conducted in order to validate instrument performance across an estuarine gradient. These experiments were designed to address: 1) reliable modes of deployment from small research vessels; 2) characterizing diel variance in active fluorescence response; 3) correlation with standard measures of phytoplankton biomass; 4) dark acclimation; 5) effects of phytoplankton concentration on variable fluorescence; 6) assessment of stress conditions (nutrients, light, etc.) on phytoplankton physiology. Preliminary results provide some practical guidance for deployment of the PhytoFlash™ for monitoring and experimental work, highlighting both potential strengths and limitations for future field investigations of phytoplankton physiology in turbid and variable estuarine systems.

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IS THERE AN ADVANTAGE TO BEING EARLY? LESSONS FROM TEMPERATE REEF FISH LARVAE

Larval stage duration and settlement size affect recruitment success of marine reef fishes. Changes in these metrics may occur throughout the spawning season relative to water temperature. The naked goby (*Gobiosoma bosc*) and striped blenny (*Chasmodes bosquianus*) are two sympatric oyster reef fishes present in estuaries along the eastern seaboard of the United States and Gulf of Mexico. In southeastern estuaries, spawning occurs from April through September, when average daily water temperatures may range between 18 and 30° C. Naked goby and striped blenny larval period duration (d), settlement size (total length, mm), growth (mm d^{-1}) and mortality at ambient temperatures (°C) were investigated during the 2013 spawning season in a southeastern estuary. Observations were made from February through October 2013 to qualitatively describe nesting activity by adult naked gobies and striped blennies. Nest observations were used to estimate the duration of the 2013 spawning season. Naked goby and striped blenny nests were first observed on April 18, 2013. Naked goby and striped blenny larvae were cultured at standard densities and prey concentrations from hatch through settlement. Larval period duration for May (23°C) hatched fishes ranged between 20 and 25 days for naked gobies and between 18 and 22 days for striped blennies. May 2013 larval period durations are longer than those reported from the Chesapeake Bay for both naked gobies (18-21 d) and striped blennies (14-21 d) at water temperatures between 26 and 29°C. Increasing water temperature will likely decrease the larval period duration and increase the larval growth rates for these fishes.

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DEPICTING SHORT EVENTS OF RIVER DISCHARGE ON TIDAL SIGNAL USING WAVELETS

Tides and river discharge play important role in hydrodynamics of the Itajaí-Açu estuary, a salt wedge estuary (southern Brazil). These effects occur in alternated way: tides prevail during low discharge periods and river discharges prevail during episodic short lasted floods. During the river floods, the tidal regime is distorted during periods that last from hours to few days. These distortions are difficult to quantify in terms of tidal harmonic analysis (HA) because the brevity of the events. This study assessed the distortions of the tides due to rapid changes on river discharge using wavelet analysis (WA). Differently from the traditional HA, the WA does not allow the identification of individual tidal constituents, such as M2, S2, etc. The WA clusters the oscillations as diurnal (D1), semi-diurnal (D2) and quarto-diurnal (D4) species, and allows the visualization of their variation in time. The WA was applied on hourly water level time series from four sites at 3, 18, 30 and 55 km from the mouth. Three 15-days periods were selected to represent conditions to represent tide dominated condition, tide with meteorological influence, and a period of river dominated condition. The tidal species showed periodic modulation following the synodical cycle in the tide-dominated period, with small variation in amplitude along the estuary, reflecting the frictionless nature of the estuary. During a condition of river influence, the D2 specie showed a rapid adjustment, being significant attenuated landwards. The time response of the tide to the river pulse was of the order of one day for the upper estuary and two days for the lower estuary. The tidal pattern took five days to return to its dominated mode after the river discharge peak. The period with meteorological influence did not show difference in relation to the tide-dominated period.

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SCENARIO-BASED FORECASTS IN SUPPORT OF REGIONAL COASTAL MANAGEMENT

Models play an increasingly important role in diagnosing environmental problems (i.e., assessing what happened), examining causes and precursor conditions of events (i.e., examining why they happened) or forecasting outcomes and future events (i.e., projecting what is likely to happen). Decision makers need to consider the ecosystem consequences of different climatic or environmental conditions, management scenarios, and/or population trends. These scenario-based forecasts are critical for enabling coastal decision-making to move from a reactive to a proactive mode. For scenario-based forecasts there is often no clear pathway for transition to application following research and development, nor objective parameters for judging when a model product becomes sufficient for its intended application. Scenario-based forecasts present unique challenges. They are typically produced on an as needed basis or on some pre-determined adaptive management cycle that may have intervals of several years, unlike model applications such as weather forecasts produced on a 24/7/365 basis. Scenario forecasts may also predict multiple future outcomes of complex ecosystems under various scenarios. This makes the communication of model assumptions and uncertainty under different scenarios critical to developing an operational decision support tool. This presentation will explore what is involved in developing, transitioning and using scenario-based forecasts in coastal management decisions. It will focus on what constitutes an operational scenario forecast considering aspects such as time scales, uncertainty, skill assessment, data requirements and communication of forecasts. Examples will include results from a regional workshop aimed at predicting hypoxia in the Gulf of Mexico and responses from a survey of coastal managers regarding their use of scenario-based forecasts. Potential pathways for transition from research to applications will be explored.

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MODELING PRIMARY PRODUCTION AND WATER QUALITY IN BAY WATERS UNDER INTERMITTENT NUTRIENT LOAD EVENTS

South Texas estuaries are characterized as shallow, windy, coastal lagoons, with long residence times. Two bays (San Antonio Bay and Copano Bay) receive the majority of nutrient load via freshwater inflow through infrequent storm events. However, these ecosystems are under increasing anthropogenic pressure of continuous nutrient loads since developed land usage increased 5.9% between 1992 and 2001 to encompass 13.1% of the entire watershed basin for the San Antonio River, which feeds San Antonio Bay. Using a previously established primary production model for the area, both systems are simulated for theoretical scenarios of nutrient loading. These scenarios include intermittent storm events and continuous anthropogenic loading of nutrients. Preliminary model results point to future increased continuous loading of nutrients as having a larger effect on primary production and water quality than infrequent storms. A possible explanation is the increased flushing time during storm events. Additionally, model results indicate higher levels of predation of phytoplankton and competition for nutrients during continuous nutrient flow periods. Because of the nonlinear responses of nutrient dynamics and bay water primary production, the timing and duration of nutrient input is critical to maintaining water quality.

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CONSEQUENCES OF INCREASED NUTRIENT LOADING TO MARSHES BELOWGROUND

Will the ubiquitous nutrient enrichment of coastal marshes stimulating aboveground plant growth also compromise soil systems? We conducted field and laboratory experiments in western Atlantic and Gulf of Mexico marshes to understand the belowground responses to N, P, and NP additions. The results for marshes with organic soils indicate that nutrient enrichment may lead to lower root and rhizome biomass, soil strength, and organic accumulation. Phosphorus additions, more than nitrogen, seems to reduce root and rhizome biomass accumulation in many, but not all marsh types. Further, the soil strength is reduced below the rooting zone. The results are consistent with the high land loss post-Katrina/Rita in the Caernarvon river diversion outflow path, but not in the reference marsh, three other diversion wetlands, and a freshwater marsh receiving tertiary sewage effluent. We conclude that sustaining and restoring coastal emergent marshes is more likely if they receive a lower, not a higher, nutrient load. This conclusion is at odds with the rationale for river diversions and sewage treatment wetlands in unconfined natural marshes. The increased nutrient loading from the Mississippi River watershed this century has also driven the formation of the low oxygen zone (Dead Zone) that forms off the Louisiana-Texas shelf each summer. Restoring either offshore or coastal wetland ecosystems necessitates, therefore, improving water quality in the watershed.

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WETLANDS AND WATER QUALITY: HOW AN ECOGEOMORPHIC APPROACH MAY RESOLVE A PENDULUM OF SCIENTIFIC PARADIGMS, POLICIES AND APPLICATIONS

Scott Nixon authored a series of papers and reports as a synthesis describing the function of wetlands related to water quality in upland and coastal wetland ecosystems. Many of these synthesis works were based on three fundamental principles of wetland and aquatic plant environments: (1) the concept of luxury consumption (that aquatic plants store nutrients above their nutritional requirement); (2) outwelling concept (a significant portion of net ecosystem production is exported to coupled ecosystems); (3) benthic-pelagic coupling (rooted aquatic plants modify anaerobic environments that stimulate elevated redox reactions, and bi-directional flux across sediment/water interface). These paradigms nearly 30 years ago promoting potential nutrient sinks in floodplains (ecotones between upland and aquatic environments) stimulated an industry of wetland wastewater treatment operations to reduce the strain of eutrophication on downstream aquatic ecosystems. Today these paradigms are challenged, particularly in coastal environmental settings, with recent evidence that wetlands are not a policy strategy to reduce eutrophication threats to aquatic systems; but are actually susceptible to nutrient enrichment additions. The key concept proposing this vulnerability to nutrient enrichment is 'biomass allocation strategies' related to resource availability, combined with the role of plants in soil strength and geomorphic development of coastal landscapes. One resolution to understanding the different observations of how wetlands respond and contribute to the fate of nutrients in coastal settings is to account for the ecogeomorphic features of the coastal setting. Recent simulation results indicate that tidal forcings, sediment flux, sea level rise, geomorphic classifications, hydroperiod, and nutrient loading rates are all factors that must be accounted to understand both response and impacts of wetlands and water quality.

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DO MUD SNAILS (*ILYANASSA OBSOLETA*) ENHANCE OR MITIGATE THE EFFECTS OF EUTROPHICATION IN SHALLOW ESTUARIES?

Eutrophication of estuaries has a selective effect on benthic invertebrate communities, eliminating sensitive species and favoring tolerant species. The omnivorous Eastern mudsnail, *Ilyanassa obsoleta* (*Nassarius obsoletus*), is more abundant under eutrophic conditions and often associated with macroalgal blooms. Using both laboratory and field experiments, our study considered the effect of *I. obsoleta* on sediment biogeochemistry and algal growth in the inner reaches of West Falmouth Harbor (WFH), where a high rate of nitrogen loading in recent years created eutrophic conditions. *I. obsoleta* "bulldozes" sediment, reworking the surface and consuming benthic microalgae (BMA) and detritus. Having observed high densities in WFH (0-1,950 snails m-2), we hypothesized that snails would increase benthic metabolism, sediment sulfide, detritus mineralization, ammonium flux and macroalgal growth, and decrease BMA. Laboratory experiments confirmed most of our predictions, although measured snail excretion was greater than the enhancement of ammonium flux by snails, suggesting rapid benthic consumption of ammonium. The effect on BMA appeared density dependent, with a decrease at higher densities and an increase at lower densities and in the field. However, in the presence of the predator (*Panopeus herbstii*), snail effects were diminished through non-consumptive effects, suggesting that under field conditions these effects may be muted. While the increased N flux to the water column suggests that snails should facilitate macroalgal growth, we did not observe this in the field, suggesting that other factors control macroalgal abundance. While our results suggest that we must take care when extrapolating from controlled laboratory experiments to the field, it is clear that the significant influence of *I. obsoleta* on benthic processes may serve as a buffer of eutrophication in shallow estuaries.

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THE EFFECTS OF DECREASED MICROBIAL DIVERSITY ON NITROGEN CYCLING IN EXPERIMENTAL MESOCOSMS

Urbanization has increased the supply of land-derived nitrogen, leading to the eutrophication of coastal habitats. This increase in nitrogen reduces macrofaunal diversity and is likely to reduce microbial diversity as well. If microbial diversity decreases as nitrogen levels rise, a positive feedback loop may result; i.e. increased nitrogen loads decrease the abundance and diversity of microbes present, which further increases the nitrogen build-up. Few studies have looked into the impact of loss of microbial diversity on ecosystem function. Microbes can respond to changes in the environment either through resistance (in which the community does not change), resiliency (in which the community has an initial response, but then returns to the baseline), or functional redundancy (in which the community changes, but the function remains the same). Whether the microbial community responds via one of these mechanisms may depend on the diversity of microbes in the environment. We determined the nitrogen cycling capacity of experimental mesocosms with reduced microbial diversity. Microbial diversity of triplicate mesocosms (20L autoclaved seawater, 2kg autoclaved sediment) was reduced with the following dilutions: undiluted, 10^-3, 10^-6, 10^-9, and no inoculate. We monitored the ammonia, nitrite, and nitrate concentrations over an initial period of 23 days. Our data show that diluted mesocosms lagged in the cycling of nitrogen; no ammonia was drawn down in any of the mesocosms except for the undiluted ones, although the 10^-3 dilution began to show elevated nitrite levels towards the end of the experimental period. DNA analysis showed that the community composition of the diluted mesocosms was different from the undiluted communities, although the 10^-3 dilution sediment DNA began to resemble the undiluted sediment DNA, indicating that this community was resilient and returning to its pre-perturbation state.

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CAPE COD'S SALT MARSH DIEBACK - MARKED ELEVATION CHANGE, SHIFTS IN PLANT DISTRIBUTION AND EROSION STEMMING FROM CRAB ACTIVITY

Denudation of salt marsh vegetation (aka salt marsh dieback) on Cape Cod, MA is driven by herbivory of a native, nocturnal crab species, *Sesarma reticulatum*. High densities of intertidal crabs at the mouth of Wellfleet's Herring River have led to large areas of bare sediments as well as rapid and surprising shifts in the distribution and abundance of palatable plant species. To quantify where and when sediments were eroding, we conducted annual ground-based elevation surveys from 2011-13. The ground based survey results were also compared to those from a 2011 airborne LiDAR survey. Estimates of the quantity of sediment lost varied widely according to the method of data collection; ground based surveys with real-time kinematic and total station equipment produced consistent and feasible loss rates. In contrast, the error associated with LiDAR was substantial even in this area of relatively sparse vegetation. Sediment accumulation rates and relative flow associated with: 5 plant species, dead vegetation and bare areas were quantified. Total suspended solids (TSS) concentrations below dieback areas as well as areas of intact vegetation were also assessed. Plant community type affected dieback erosion rates as measured by TSS with the maximum difference in TSS concentration five times higher at a dieback site than at a vegetated site. Shifts in plant distributions driven by elevation change, herbivory and sediment characteristics have occurred. Difference in the susceptibility to herbivory as well as sediment accumulation rates associated with different communities will synergistically lead to continued rapid change in the physical and biological characteristics of this site. The predicted consequences for the ecosystem function of this site and similar dieback sites in the region will be discussed.

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CARBON BURIAL IN SALT MARSHES: A COMPARISON OF A COASTAL LAGOON AND COASTAL PLAIN ESTUARY IN THE MID ATLANTIC U.S

Carbon (C) burial in salt marsh soils is a beneficial ecosystem service that occurs as a result of in situ macrophyte production, slow decomposition, and deposition of allochthonous mineral sediments. Rates of C accumulation vary within and among salt marshes, and the factors influencing this variation are poorly understood. Differences in tidal range and sediment availability between a coastal plain estuary and a coastal lagoon provide the opportunity to examine variation in C burial and belowground biomass composition. Eighteen soil cores approximately 60-cm long were collected in Spartina alterniflora-dominated areas of the two estuary types and analyzed for accretion rate, C and sediment accumulation rates and coarse and fine root morphology. In Delaware Bay, the coastal plain estuary, aboveground live biomass was over three times higher and coarse and fine root biomass was slightly lower than in Barnegat Bay. Mineral sediment accumulation rate ranged from 74 g m-2 yr-1 in the lowest elevation lagoonal marsh to 3293 g m-2 yr-1 in the marsh along a large tributary to the Delaware Bay. C accumulation ranged from 50 to 237 g m-2 yr-1 in the same sites. Sediment accumulation was ten times greater while C accumulation was two times greater in Delaware Bay than in Barnegat Bay. Our results support the hypothesis of a positive yet disproportionate relationship between sediment and C accumulation rates.

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ABIOTIC LIMITATION OF NON-NATIVE PLANTS IN THE HIGH SALT MARSH TRANSITION ZONE

Native plants in the upland to high-marsh transition zone of southern California salt marshes are mostly perennials, and therefore experience the abiotic stress of low soil moisture and high soil salinity throughout much of the year. However, many annual non-native plants reproduce during the brief period of reduced salinity and increased moisture during winter rainfall. We investigated the seasonal and spatial variation in vegetation and soil properties of the transition zone using an observational study. Next, we explored the potential for managing non-native plants using a field experiment with varying timing, quantity, and frequency of salt addition treatments. The observation study showed that the distribution of non-native plants is related to changes in soil salinity and soil moisture that accompany changes in elevation, although there are variations among species. In the field experiment, salt was effective at reducing non-native plant cover, but the timing of treatment was important. Although additional work is needed to refine the salt treatments, this work supports the idea that altering abiotic conditions can effectively reduce the presence of non-native species in the upland to high-marsh transition zone.

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RECOVERY OF ORGANIC ENRICHED SEDIMENTS IN EUTROPHIC COASTAL ECOSYSTEMS

Eutrophication can enrich sediments in coastal ecosystems several fold, which may have negative consequences for ecosystem functioning. Water clarity is reduced due to increased resuspension of organic enriched sediments. The areal distribution of rooted marine macrophytes shrinks, since organic rich sediments is poor anchoring substratum for plants. Finally, decay and release of sediment bound nutrients to the water column may counteract legislative measures to reduce dissolved nutrient levels. Degradation of excess sedimentary organic matter is therefore a prerequisite for a full reversal of eutrophic conditions in coastal ecosystems. Here we summarize the results of an experiment designed to investigate the natural recovery of sediments enriched with organic matter and nutrients after decades of eutrophication. Organic rich sediments were collected from the eutrophic Odense Fjord, Denmark, and microbial degradation and nutrient dynamics was followed in long term experiments lasting ~2 years. Common biogeochemical methods were used to quantify C, N and P remineralization. Results were fitted to exponential decay models, which provided important information regarding the long-term fate of organic matter and nutrients. The results suggest that coastal ecosystems are irreversibly changed by eutrophication. Only ~1% of accumulated organic matter was labile (half lives of 0.5-3 months) whereas another 4-58% was degradable over long time scales (half lives of 1-23 years). A large proportion of sedimentary organic matter (41-95%) thus appeared virtually non-degradable. Hence full ecosystem recovery may be difficult to achieve in eutrophic ecosystems. On the other hand, nutrient release from organic enriched sediments faded to insignificant levels within 1-4 months, suggesting that internal nutrient loading is of limited importance in eutrophic estuaries with short water residence times.

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RESPONSE OF A SUBTROPICAL STRATIFIED ESTUARY TO RIVER PULSES

The Araranguá Estuary is one of a series of river-dominated, narrow (<200 m wide) estuaries along the southern Brazilian coast. These systems are microtidal (tidal range < 1 m) and flash-flood influenced. A special feature of the Araranguá is that depth increases landward, as its lower stretch runs parallel to a wave dominated sand-bar. Water level, currents profiles, and near-bottom salinity and temperature were recorded at 7 and 30 km from the mouth during 70 days. Three pulses of moderate river discharge occurred during the observation period. Hydrographic data showed a highly-stratified, salt-trapping system. Time series data showed that the estuary responded non-uniformly to river pulses. In the lower estuary, the exchange flow was modulated by tidal forcing. Subtidal variations and the deployment-long averaged hydrodynamics were explained reasonably well by a balance between pressure gradient and friction. In contrast, the upper estuary showed that subtidal variations were determined by river pulses through an upper active layer. The mean flow was relatively uniform within the upper and lower layers, moving in opposite directions but coupled by an intermediate frictional layer. Overall, the estuarine circulation resembled that of a fjord, with an active upper layer driven by river discharge moving over a stagnant lower layer.

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CHANGING SEDIMENT DYNAMICS AND MERCURY RE-MOBILIZATION IN THE SOUTH SAN FRANCISCO BAY SALT POND RESTORATION PROJECT

The South Bay Salt Pond Restoration Project (www.southbayrestoration.org) is the largest tidal wetland restoration project on the West Coast. When complete in 50 years, the project will restore 15,100 acres of former industrial salt ponds to a mosaic of tidal wetlands, managed ponds, and other habitats. San Francisco Bay has lost about 85 percent of its historic wetlands that has caused populations of marsh-dependent fish and wildlife to dwindle, decreased water quality, and increased local flood risks. Restoration of the South Bay salt ponds provides an opportunity to begin to reverse these trends by improving the ecosystem functions of San Francisco Bay for years to come. Restoration at this scale has generated a number of uncertainties for the South Bay, including: 1) Will the natural accretion rate of sediment in ponds opened to tidal action be sufficient to reach vegetation colonization elevations? 2) Is there sufficient sediment entering the far South Bay to support the amount of restoration planned? 3) Will legacy mercury be significantly re-mobilized due to tidal restoration and/or pond management? This presentation will provide a summary of the key scientific findings to date. Sediment accumulation studies inside Pond A6, breached to tidal flows in December 2010, have found an average accumulation rate of 20.2 cm/year in the first 28 months since breaching. Scour studies in the sloughs adjacent to the breached pond indicate that the greatest erosion in the slough is occurring bayward of the breaches. The average erosion in these areas is about 20 cm, with localized erosion directly adjacent to the breach locations exceeding 75 cm. Preliminary data indicate that the scour has re-mobilized 11 – 13 kg of total mercury, with the majority of the Hg released by sediment scour near the Pond A6 breach locations. We will share our insights into the challenges and uncertainties of a large restoration project, especially in light of future sea level rise.

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ASSESSING AND COMPARING THE RESILIENCE OF SALT-MARSH ECOSYSTEMS USING EXPERIMENTAL DISTURBANCES

IIn recent years many studies have contributed to our understanding of the key mechanisms and processes that drive salt-marsh dynamics. Yet, our ability to predict the onset of large-

scale salt-marsh degradation, or its recovery, is limited due to the inherent non-linear nature and threshold behaviour of these processes. Thus, there is a need for new ways to probe the resilience and vulnerability of salt marshes. Theory suggests that early-warning indicators exist that inform on deterioration and loss of resilience in complex natural systems. The concept of critical slowing down provides an appealing approach to assess proximity of tipping points in ecosystems. This concept uses changes in recovery rates following disturbances as early warning for imminent loss of resilience. However, how to use this indicator for assessment and comparing of salt-marsh resilience and vulnerability to changing environmental conditions is not apparent. Here, we present a combined theoretical and empirical study to understand how to interpret critical slowing down along environmental gradients in salt-marshes in terms of their vulnerability to changing conditions. Using a minimal spatial model, we first show that when salt-marshes experience strong disturbances, switches in community structure occur before the theoretical tipping point is reached. This leads to the prediction that, when salt-marshes experience different disturbance intensities, the critical recovery rate measured just before an observed switch to tidal flat, is determined by the disturbance intensity. Field experiments in salt marshes confirm this prediction, revealing that between-site differences in recovery rates at the salt-marsh leading edge, are best explained by their exposure to stormy conditions. Hence, comparing recovery rates in different salt-marshes does not inform on the resilience of these coastal wetlands to sea level rise and their vulnerability to increasing storminess.

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ECOSYSTEM ENGINEERING IN A CHANGING COASTAL ENVIRONMENT: CONTEXT-DEPENDENT EFFECTS OF SHELLFISH ON BENTHIC COMMUNITIES

Habitat-modifying species, i.e. ecosystem engineers, are considered important in steering intrinsic ecosystem dynamics because these organisms structure communities, ecosystem functioning and landscape complexity. However, ecosystem state shifts that are driven by stressor-induced changes in ecosystem engineering outcomes remain poorly predictable because the generality of interaction strengths is often not understood. A stressor that is likely to affect interaction networks in coastal soft-sediment ecosystems is the change in hydrodynamics that instigates changes in bed shear stress, water-borne suspended sediment concentrations, and sediment type. We present evidence from two field experiments about how the effects of two functionally different shellfish species on benthic communities in shallow coastal habitats relates to differences in suspended sediments and the physical disturbance of the sediment bed. These insights were obtained from species population density manipulations across turbidity gradients at locations that differ in hydrodynamic forcing. Results illustrate that inhibitive bioturbation interference effects of the filter-feeding cockle Cerastoderma edule on surface-dwelling populations are enhanced with increases in suspended sediment concentrations and that juvenile organisms are most vulnerable to such effect, but also that physical disturbance of the sediment may obliterate this effect. Similarly, the negative effect of the deposit feeding clam Macomona liliana on microalgal biomass and densities of meiofaunal organisms that live in the surface sediment was only demonstrated for finer sediments that are indicative for lower hydrodynamic disturbance of the sediment bed. We discuss these results in relation to stressor-induced change in shellfish behavior to contribute to the understanding of benthos-mediated influences on ecosystem properties and therefore the resilience of these systems to environmental change.

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IS SALINITY VARIABILITY A BENTHIC DISTURBANCE?

Freshwater inflow to the coastal zone is important for maintaining the ecological health and productivity of estuaries. Many past studies have shown that benthos are good ecological indicators of inflow effects. There is a great amount of ecological theory that links stability of ecosystems to diversity. Because inflow arrives in pulses, it can be viewed as a disturbance or stress, and it is possible to apply theories about diversity maintenance to inflow as a stress or disturbance. Using freshwater inflow as a stress event and benthic communities as a model system to monitor the response to stress, it is possible to ascertain how these benthic communities respond to a disturbance of environmental conditions. In freshwater inflow studies, the mean salinity is usually measured to record environmental quality levels. But the variability of salinity as expressed as the variance of salinity could be an indicator of a disturbance factor. Four distinct bays along the southern Texas coastline (Laguna Madre, Corpus Christi Bay, Lavaca Bay, and San Antonio Bay) each with different salinity regimes were studied, and the responses of benthic communities to salinity variance were analyzed for a period of 20 years. Diversity is used as an indicator of community health and integrity; biomass is used as an indicator of community function to measure the ability of a system to respond to stressful disturbance events. The over-arching purpose of this study is to explain how ecosystems respond to changes in freshwater inflow to develop information useful for managing ecosystem health.

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NEXT-GENERATION SEQUENCING ADVANCES FOR SEAGRASS BARCODING

Seagrasses are a specialized ecological group of marine flowering plants. Only a small number of species (ca. 70) have adapted to survive fully submerged in the marine environment. The process of adapting to this environment has been extreme for these flowering plants all belonging to the same order of monocotyledons (Alismatales). This has led to many morphological characteristics becoming reduced or lost complicating seagrass taxonomy due to the limited number of defining characters. DNA sequencing and phylogenetic analysis has shown that characters such as leaf size or shape are not necessarily useful to effectively define species concepts. In the genus Halophila specimens collected from different sites can differ more than an order of magnitude in size and belong to the sample phylogenetic group, while specimens that are similar in size and shape belong to different groups and potentially represent cryptic species. The Global Initiative to Barcode Seagrasses (GIBS) is developing genetic barcodes that will allow differentiation of all seagrass species. Following the guidelines of the Consortium to Barcode Life (CBOL), GIBS will result in a molecular taxonomy that will inform taxonomic research to resolve a practical taxonomy for seagrasses. DNA Barcodes are short easy to generate sequences that are sufficiently diverse to delimit species. Barcodes are particularly useful when working with samples that lack the necessary morphological characters to classify them or with environmental samples such as feces. Barcoding is traditionally done by Sanger sequencing where only one sample per locus at a time. The availability of Next Generation Sequencing (NGS) able to generate millions of short sequences in one run, reducing the cost per sample and increasing the number of loci per sample. GIBS is developing a NGS seagrass Barcoding protocol that will deliver dozens of barcoding loci per run for only a fraction of the cost per sample.

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RECOVERY OF SEAGRASS BEDS. ACCELERATION THROUGH PLANTING SCALE EFFECTS AND ECONOMIC INCENTIVES

Seagrass beds form highly threatened ecosystems, although occurring throughout coastal basins worldwide. Despite decades of zero seagrass loss policies mandated in many nations and regulating seagrass by conservation, global seagrass loss has accelerated since 1980. Quantitatively, seagrass revegetations increased 10-fold after the 1980's, but form a small

percentage of the loss. Analysis of 215 revegetation studies conducted within 17 nations shows average revegetation success rates have not increased, revealing lack of learning. This supports our in-depth analysis to identify drivers of success and economic benefits of seagrass restoration. We demonstrate that larger scale efforts are beneficial to both survival and expansion of the revegetation (> 10 000 shoots or seeds planted). As the majority of projects have remained small over the last decades, this likely explains why success rates have not increased. The scale-dependency correlates with the large number of recently identified positive feedbacks in seagrass systems – a phenomenon potentially leading to sudden collapses but also to accelerated recovery once a critical threshold is surpassed. In addition, the positive effect of large scale revegetations implies that naturally occurring small-scale recovery will be catalysed by extra planting. Seagrass revegetation is shown to be cost-neutral within 14 years solely on the basis of optimal market prices of carbon sequestration for climate change mitigation. During this period, added economic value arises from seagrass-based fisheries yields, nutrient cycling values, sediment stabilisation, and enhanced biodiversity. Our analysis thus provides strong ecological evidence and public economic incentive for accelerating global efforts in restoring valuable seagrass meadows.

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COUNTRY-WIDE ASSESSMENT OF ESTUARY HEALTH: LARGE VERSUS SMALL ESTUARIES

As part of South Africa's international biodiversity protection obligations the country reports on ecosystem condition every five years. National-scale pressure data were collated on freshwater inflow modification, water quality (effluent discharges, agricultural activities), artificial breaching, habitat modification and living resources exploitation to report on estuary ecosystem status. A desktop national health assessment was concluded for nearly 300 estuaries and was based on the environmental flow requirement method developed for South Africa (applied to over 30 estuaries at various levels of data richness and confidence). National experts, all familiar with the index, were used to evaluate the systems in their region. The individual estuarine health assessment scores were then translated into health categories and aggregated for the various estuarine ecosystem types to reflect the overall ecosystem status of SA estuaries. One of the major findings of the study was that while a large number of estuaries were still in an "excellent" to "good" conditions, they represented very small systems. The larger, important nursery systems were of "fair" to "poor" quality, indicating a general decline in health and highlighting one of the reasons for the slow stock recovery for linefish species. This desktop approach is being refined to systematically link flow and water quality pressures to condition on a regional scale, based on estuary specific features. This will allow for strategic scenario planning for regional water resource management or climate change predictions. The model clearly shows that the numerous small temporarily open/closed estuaries along the South African coastline have little resilience to flow and quality modifications and that small changes can cause a rapid decline in condition.

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THE INFLUENCE OF GRAIN CHARACTERISTICS ON SEDIMENT DEPOSITION WITHIN SALT MARSH AND TIDAL CREEK SYSTEMS IN THE BAY OF FUNDY

The purpose of this presentation is to investigate the influence of grain characteristics (organic matter content, floc fraction and grain size on sediment deposition within intertidal ecosystems in the Cornwallis estuary. Hydrodynamics and resultant sediment deposition were recorded over a total of 92 tides from 2009 to 2013 at 3 sites ranging from an end member salt marsh tidal creek to an open intertidal system. Sediment transport processes were recorded using a range of acoustic and optical instruments in the tidal creek and adjacent marsh surface. Sediment deposition was measured using surface mounted sediment traps. One filter per station was processed for organic matter content and Disaggregated Grain Size analysis using a Coulter Multisizer 3. Inverse modelling procedures were then used to separate floc versus single grain fractions. Sediment deposition varied between intertidal environments with significant differences in creek versus marsh surface and tidal amplitude. The grain size spectra between tides were very similar, and the highly flocculated nature of the material leads to more rapid settling with higher suspended sediment concentrations and more resultant deposition with a greater volume of water. However sediment deposition is not linked to changes in floc fraction. Suspended sediment is consistently highly flocculated, and high incoming SSC encourages rapid settling with calm conditions. Increases in flow velocity and bed shear stress increase the proportion of coarse particles in deposited material, however is spatially variable. Overall, these findings provide important baseline information regarding natural variability in biophysical processes and the resilience of intertidal ecosystems to respond to changes in the environment that can be applied to computer models currently being developed to investigate the potential far-field effects of tidal energy extraction.

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LINKING FUNCTIONAL DIVERSITY OF MICROBIAL AND MACROFAUNAL COMMUNITIES WITH ECOSYSTEM FUNCTIONING IN FIELD SITUATIONS: RESULTS FROM SHALLOW NORTH SEA SEDIMENTS

Benthic microbial ecologists often reported on the positive link between microbial diversity en certain ecosystem functions, including organic matter (OM) mineralisation. Ecologists working with metazoan organisms stressed the link between functional diversity of macrofauna and mineralisation rates, as macrofaunal activity (1) transports OM and (2) oxygen in the sediment and (3) increase sediment heterogeneity. Furthermore, it has been reported that the presence of macrofaunal organisms affects microbial communities. All these separate lines of investigations are mainly pursued through experimental research, hence an integrated upscaling to the "real world" remains difficult. Here, we report on such an attempt. Natural disturbances in shelf seas include the sedimentation of OM after a phytoplankton bloom, triggering shifts in the benthic communities and altered ecosystem functioning rates. We sampled muddy, fine sandy and permeable sediments during the phytoplankton bloom (April), shortly after mass sedimentation (June) and at the moment of highest sea water temperature (September). We sampled for macrofauna, general bacteria and archaea, ammonia oxidising bacteria (AOB) and archaea (AOA) while measuring sediment oxygen consumption and modelling nitrification rates (i.e. the process mediated by AOA and OAB). Peak mineralisation rates coincide with highest temperature, while a clear general link between macrofaunal functional diversity and nitrification is obvious. Spatial and temporal patterns of AOB and AOA are more different than those observed from the general communities. Highest mineralisation rates coincide with highest diversity of AOB and AOA. Our results thus reveal a coupling of macrofaunal diversity and microbial diversity, but suggest that physical forcing plays an important role in permeable sediments as well. Our results further indicate that the diversity of AOA and AOB is enhanced by the habitat-modifying macrofauna and the presence of OM.

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AN ATLANTIS ECOSYSTEM-BASED APPROACH TO MODEL EFFECTS OF HYPOXIA ON THE FOOD WEB OF THE NORTHERN GULF OF MEXICO

The Northern Gulf of Mexico (NGOMEX) experiences extensive summer hypoxia. The impact of hypoxia on the production of commercially and recreationally important fish and shellfish remains equivocal. Ecosystem-based models might help to identify species of fish and invertebrates that are significantly influenced by the seasonal 'dead zone' of low dissolved oxygen in this area. By using the Atlantis framework, the ecosystem dynamics of the NGOMEX were modeled in a three-dimensional biogeochemical and biophysical modeling system that uses a hydrodynamic model output as a forcing function and simulated biogeochemical cycles and food web interactions. Nutrient inputs for nitrate+nitrite and ammonia from the USGS Mississippi-Atchafalaya River station data provided a monthly time scale interpolated to the 15-day time step required for Atlantis river inputs. This was used as the major driver to mimic the hypoxic zone. The initial nutrient tracer values and hydrodynamics inputs were also crucial in the process of first modeling the dead zone and then determining which species were impacted. Species distributions were obtained from the Southeast Area Monitoring and Assessment Program (SeaMap) The life history information for each fish and age-structured invertebrate species were compiled from databases and articles, with typically ten life stages. Our initial results provide an assessment of the future effects of an increase in the spatial extent of the dead zone across the continental shelf region during the summer and fall over multiple years on aquatic living resources.

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USING ECOPATH WITH ECOSIM TO MODEL POWER PLANT IMPACTS IN A LAGOONAL ESTUARY

Multi-trophic level models have historically been used to assess changes in aquatic systems associated with biomass removals from fishing. Recent models have sought to understand the changes in aquatic systems associated with changes in environmental parameters or habitat. In our study, we forecasted potential changes to the estuarine community of Barnegat Bay, a lagoonal estuary in southern New Jersey, associated with the impending decommissioning of the nation's oldest continuously operating nuclear reactor. The reactor utilizes a once-through cooling system, and thus acts as a source of quantifiable mortality through impingement and entrainment effects. Model runs incorporating reductions in impingement and "impingeable size" entrainment mortality did not show a substantial increase in biomass of any community members. Estimates of abundance and mortality relating to entrainment of young-of-the-year fishes and crabs smaller than impingeable size were previously calculated, but no biomass estimates were readily available. As this smaller class of biota likely represents a substantial fraction of the biomass impacted by the power plant due to their numerical dominance, a separate model was constructed using a number of assumptions from the literature to develop estimates of their biomass. The results of this model diverged from the original model results, suggesting that mortality of the numerically dominant early life history stages associated with the plant operations plays an important role in regulating community dynamics.

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USE OF A HYBRID PHYSICAL-ECOLOGICAL MODEL FOR PREDICTING THE EXTENT AND DURATION OF HYPOXIA IN THE ESTUARINE WATERS OF NARRAGANSETT BAY, RI, USA

Ecosystem-level models are becoming a common tool for informing decisions regarding coastal water quality and land use in the surrounding watersheds. Many of these models are complex, containing numerous parameters that are difficult to constrain. Some also require long run times to model a relatively short time span. As part of the NOAA Coastal Hypoxia Research Program (CHRP), we have developed a hybrid model of Narragansett Bay, RI which couples mixing results from the fine-grid Regional Ocean Model System (ROMS) with a coarse-grid, mid-complexity ecological model. This hybrid model generates estimates of water column chlorophyll-a, nitrogen, phosphorus, dissolved oxygen, and benthic carbon. Once the physical mixing coefficients have been generated from the ROMS model, simulating a year of the ecology for the whole estuary takes less than a minute on a desktop PC. The constants and coefficients used in the ecological model are relatively few and appropriate ranges have been empirically constrained. The model was validated using cruise data from multiple dates, water quality sondes deployed in ten locations as part of a buoy network, sediment core incubations, and water column productivity incubations. The model currently includes simulations for the time period from January 1, 2006 through December 31, 2007. These two years bracket the typical duration and extent of hypoxia, providing a "worst case / best case" scenario for predicting the effect of management actions on hypoxia in Narragansett Bay. A user-interface allows for reduction of nutrient inputs in each of the rivers and waste water treatment facilities, allowing for an evaluation of the potential effect of management actions on the water quality of Narragansett Bay.

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INTENSIVE SHELLFISH FARMING IN MEDITERRANEAN LAGOONS: EUTROPHICATION CONTROLS, FEEDBACK LOOPS AND COMMUNITY SHIFTS

In the Mediterranean region, shellfish (clams, mussels and oysters) are farmed especially in eutrophic lagoons which are influenced by river inputs. Different shellfish species can have diverse impacts on water and ecosystem quality due to the farming management. Clams are grown at the sediment surface, mussels with hanging ropes, and oysters in cages either hanging in the water column or laying on the sediment surface. The common feature of all species is the quick recycling of ammonium, mineral phosphates and silica from particulate organic matter (POM), often shifting N:P:Si stoichiometry which can influence interactions between phytoplankton and macroalgal species. Shells can also act as hard substrata facilitating the first development phase of ephemeral macroalgae. Clams being grown at the sediment floor can rework the superficial sediment, allowing its mixing with effects on oxygen and nutrient fluxes. Moreover, clam harvesting is performed by dredging, which has deep effects on sediment granulomtery, e.g. causing the fine fraction loss, organic matter content and redox. Mussel ropes impair shellfish - sediment interactions, causing POM accumulation at the sediment surface due to settling feces and pseudofeces. POM accumulation leads towards anaerobic microbial processes with detrimental effects on farming itself, especially in sheltered sites. Field and mesocosm experiments demonstrate that above certain biomass densities, shellfish farming can induce feedback loops between molluscs and primary producers, e.g. the shift from phytoplankton towards macroalgae and from aerobic towards anaerobic microbial metabolism. Densities thresholds are also influenced by environmental factors, e.g. temperature and hydraulic retention time, and sedimentary geochemical features, e.g. the presence of carbonates. Above certain thresholds, frequent dystrophic outbreaks can deeply impact biogeochemical processes until farming itself becomes unsustainable.

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DIPOLE FORMATION BY TIDAL FLOW AT SAN QUINTIN BAY

San Quintín Bay (SQB) is located in the Pacific coast of Baja California, Mexico. Tides are the main driving mechanisms controlling the water movement and the exchange with the open ocean through a narrow entrance. The bay is highly productive due to upwelled waters being transported from the open sea into the bay. To study tidal exchange between San Quintín Bay and the open ocean we introduce the concept of "tidal pumping" characterized by an ebb-flood asymmetry, in which ebb flow comes out from the bay as a jet with dipole formation while flood as a radial sink. When the flow passes through the narrow entrance the no-slip walls and the sharp corners divide the flow and the detached sheet of strong vortices rolls up on itself to create a vortex (Wells and Heijst, 2004). These structures make the tidal pumping more efficient (Wells and Heijst, 2003). Some field experiments with buoy drifters and ADCPs have shown the formation of eddies outside SQB. The Delft3D numerical model is being applied to determine the water exchange through tidal forcing. The eddy formation is observed to depend on tidal conditions and tend to migrate offshore. Eddies can trap passive tracers inside a vortex which are transported large distances, thus this study suggests that the eddy enhances the ebb flow allowing the entrance of well mixed water into the bay (by tidal straining).

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CHANGES IN PUERTO RICO'S WETLAND COVERAGE AFTER INDUSTRIAL AGRICULTURE DECLINE

In this project we intend to use historic aerial photographs, spatial images and remote sensing analysis to study the changes in coastal vegetative wetland cover for Puerto Rico following the period of agriculture decline until present (1940-2010). We intend first to look at aerial images that include near infrared band to delineate herbaceous and forested wetlands for the year 2010. Once delineated we can trace back coverage to the years 2000, 1990 and 1980 to ascertain changes in different types of coastal vegetative wetlands using aerial imagery available from the Puerto Rico Department of Natural and Environmental Resources (DNER) as well as Landsat satellite images. For the timespan covering 1940 until 1970, we intend to use historic aerial photographs available from DNER and the Puerto Rico General Archives. We expect the biggest contributor to wetland recovery in general, as in the case of mangrove forests, to be regulatory, as in the decade of the '70s important legal framework was put in place for the protection of these ecosystems and following, a decade of improvement occurred (Martinuzzi et al., 2009). Socio-economic, historical and regulatory factors of the study areas based US Census Data and short interviews and/or focus groups, will be considered coupled with existing literature on causes of coverage increase and decrease: Aide et al. (2000), Martinuzzi et al. (2009), Gould et al. (2012), and Álvarez-Berríos et al. (2013). Using ArcGIS and FRAGSTAT software we intend to analyze the fragmentation of coastal vegetative wetlands in the selected study sites and prevalent land-cover categories. Following, a modeling component will be included as to use the pattern analysis, socio-economic and physical factors as inputs for automated cellular software runs in order to build a model of future cover changes in coastal vegetative wetland cover for the next 30 years, taking into account different sea-level rise scenarios.

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THE ROLE OF RECURRENT DISTURBANCES FOR ECOSYSTEM MULTIFUNCTIONALITY

Ecosystem functioning is threatened by an increasing number of anthropogenic stressors, creating a legacy of disturbance that undermines ecosystem resilience. Still, few empirical studies have assessed to what extent an ecosystem can tolerate repeated disturbances and sustain its multiple functions. By inducing increasingly recurring hypoxic disturbances to a sedimentary ecosystem, we show that the majority of individual ecosystem functions experience gradual degradation patterns in response to repetitive pulse disturbances. The degradation in overall ecosystem functioning was, however, evident at an earlier stage than for single ecosystem functions, and was induced after a short pulse of hypoxia (i.e. 3 days), which likely reduced ecosystem resistance to further hypoxic perturbations. The increasing number of repeated pulse disturbances gradually moved the system closer to a press response. In addition to the disturbance regime, the changes in benthic trait composition as well as habitat heterogeneity were important for explaining the variability in overall ecosystem functioning. Our results suggest that disturbance-induced responses across multiple ecosystem functions can serve as a warning signal for losses of the adaptive capacity of an ecosystem, and might at an early stage provide information to managers and policy makers when remediation efforts should be initiated.

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THE ROLE OF HISTORIC WETLANDS IN THE ESTABLISHMENT AND MAINTENANCE OF *PHRAGMITES AUSTRALIS* IN COASTAL DUNE HABITAT OF CAPE COD, MASSACHUSETTS

A variety of invasive species can be found along the coastal dunes of Cape Cod, Massachusetts. One such species is *Phragmites australis* (common reed), an aggressive plant that typically out-competes natives for space and resources. Extensive coastal erosion resulting from winter storms of 2012 has provided insight into one mechanism that aids in the proliferation of *P. australis* along the sand dunes at Coast Guard Beach. Portions of a 9,000-year old wetland were exposed approximately 4.6 meters below the dune surface. The peat from this wetland provides a semi-impervious surface that traps lateral groundwater flow and rain water filtering down through the sand layer. Viable roots and rhizomes from *P. australis* were observed growing in this peat layer, suggesting a competitive advantage for *P. australis*. Current thought is that *P. australis* was present at the time when the freshwater wetland was active and prior to dune formation. If confirmed, this would suggest that *P. australis* grew upward in concert with dune development, with the original roots and rhizomes anchored in the freshwater peat providing water and nutrients in an otherwise limiting environment (sand dunes). Thus, the historical freshwater peat layer allows *P. australis* to persist in coastal dune habitats along Cape Cod.

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BURROWING IN BEACH FILL: IMPLICATIONS FOR RECOVERY OF SANDY BEACH ECOSYSTEMS

Beach nourishment is often considered an environmentally sound approach to maintaining eroding shorelines, however, the ecological consequences of this practice are poorly understood. Beach fill activities cause intense mortality of beach macroinvertebrates, potentially altering these intertidal communities for months to years. Ecological recovery following large scale fill activities depends on successful recolonization of the entire intertidal community from offsite sources. The use of incompatible fill sediments can impede recolonization of intertidal invertebrates. We hypothesized that both intertidal zone and burrowing mode could influence responses of beach invertebrates to altered sediment texture, and ultimately the potential for colonization and recovery of beaches disturbed by fill projects. We tested these predictions when a dredge disposal project at Goleta Beach, California introduced mismatched fine sediments (28 – 38% fines) to all zones of the beach in 2011. Experimental trials in fill material and native beach sand found the fine fill sediments significantly inhibited burrowing of characteristic species from all intertidal zones, including hippid sand crabs, clams, oniscoid isopods, talitrid amphipods, and polychaetes. For several species, burrowing was completely inhibited in the fill, excluding the animals. We also found burrowing of lower intertidal species was sensitive to sediment mixtures with <10% fines. Burrowing inhibition by mismatched fill sediments exposes beach species to stresses, which could depress recruitment and survival at all intertidal levels. Our results suggest use of incompatible fill sediments creates unsuitable habitat that could significantly delay intertidal community recovery. By reducing the availability of intertidal invertebrate prey, impacts of filling could affect shorebirds and fish and extend beyond the beach itself.

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SO WHAT? TRANSLATING SCIENCE INTO MANAGEMENT: SOME HURDLES

Best ecosystem management practices are best achieved by having a well-informed public. “The main problem is not science—we understand fundamental processes and natural laws OK. The main deficiency is in the organization and utilization of that knowledge and in the political or social processes whereby that knowledge is applied” (McNarry 2013). There are several hurdles to this process of applying that knowledge—politics, economics, resistance to change, culture, customs, bias, and old paradigms. These hurdles will be illustrated by the perception of science by scientists, educators, the public(s), politicians, and students. We know a lot about many ecosystems. The Indian River Lagoon, my example, recently (2009-2011) experienced a superbloom and a loss of half its seagrass. So what? That is, given what we now know, what should be our (society’s) next step? Are we even asking the right questions? Suggestions will be offered.

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TESTING WHETHER THE LACK OF SEAGRASS RECOVERY IS RECRUITMENT LIMITED IN INDIAN RIVER LAGOON, FL

The Indian River Lagoon lost 140 square kilometers of seagrass (about half) between 2009 and 2011 due to a phytoplankton “superbloom.” Extensive areas that had previously had seagrass still have zero seagrass in 2013. Why has recovery in some areas not even started? Sediments and water quality, primarily water clarity, appear good for supporting seagrass. To test whether recovery is recruitment limited, several 12-cm diameter plugs of *Halodule wrightii* were planted at several sites up to 50 km apart without any seagrass. Some plugs were not protected from large grazers, primarily manatees; others were (we thought). After planting in July 2013, all the protected plugs had survived a month later. A few plugs had started to spread. The experimental design and preliminary results, some unexpected, will be presented.

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SALINITY AND FERTILIZATION EFFECT ON GROWTH AND BIOMASS OF *TYPHA DOMINGENSIS*

Typha domingensis has a worldwide distribution and is found in fresh and oligohaline wetlands in temperate and tropical climates. Although this species is common in Louisiana’s coastal wetlands, little is known on the effect of salinity and eutrophication on its distribution. We exposed plants harvested from a Louisiana wetland to 5 different salinity treatments (0, 1, 2, 4, and 8 ppt) and 6 different levels of fertilizer (0, 0.1, 0.2, 0.4, 0.8, and 1.6 g of N per pot). We measured total leaf length weekly and above and below ground biomass at the end of an 8 week experiment. We found that the growth rate and aboveground biomass of *T. domingensis*s was positively and linearly affected by the fertilizer addition, and that salinity had a negative effect of aboveground biomass. For the relative growth rate, there was a significant interaction between fertilization and salinity. At low fertilization, there was very little effect of salinity on growth, while at high fertilization rates growth was markedly lower at the higher salinity levels. Belowground biomass was unaffected by any of our treatments, probably due to the relatively short duration of the experiment. The relationships documented with this experiment will be useful for models that forecast *T. domingensis*is distribution in coastal Louisiana.

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THE EFFECT OF STRUCTURAL COMPLEXITY ON THE INTERACTION STRENGTH OF KEY CONSUMERS IN A TEMPERATE SEAGRASS ECOSYSTEM

Seagrass habitats are an integral part of coastal marine ecosystems, promoting increased species diversity and high primary productivity. Both top-down (grazing, predation) and bottom-up (nutrient loading) processes may regulate seagrass growth, abundance, and structural complexity. Epiphytic algae, which grow on seagrass blades, are capable of outcompeting and effectively smothering seagrasses when nutrient loads are high. However, mesograzers (e.g. gammarid amphipods, isopods, shrimp, and snails) consume epiphytic

algae, promoting seagrass growth. In turn, dense, structurally complex seagrass may house diverse and abundant mesograzer assemblages, potentially resulting in a positive feedback loop that maintains dense seagrass patches. In light of this, we assessed how structural complexity (shoot density) affects the functional roles of mesograzers in terms of their affect on epiphytic algae abundance and seagrass productivity. We transplanted eelgrass (Zostera marina) from San Diego Bay, CA into laboratory mesocosms at three shoot densities (400, 600, and 1200 shoots m-2) and quantified the interaction strengths of three algal grazers on epiphyte abundance and seagrass productivity: the carinate dove shell snail, Alia carinata; grass shrimp, Hippolyte californiensis; and amphipods, Gammaridae spp.. The results of this study are not only pertinent to seagrass conservation and management but also to further understanding the principles governing consumer-prey interactions.

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REGIONAL ASSESSMENT OF TRASH IN SOUTHERN CALIFORNIA STREAMS

Stormwater agencies have long recognized trash as a key stressor to water quality conditions in southern California. The coastal estuaries, which are the nexus between the rivers and the ocean, accumulate the trash from the watersheds that creates visual and environmental issues for the wetlands. Recognizing that trash is a significant issue to be addressed, the Southern California Stormwater Monitoring Coalition Regional Monitoring Program (SMCRMP) began a regional project to assess trash using a probability based design that assesses conditions across open space, agriculture, and urban land uses within the region's 15 major watersheds. The goal of the regional trash assessment study is to improve our understanding of the spatial distribution and magnitude of trash problem at both local and regional scales as well as examine trash sources and pathways into the streams. The results from the regional assessment show that approximately 73% of stream-miles in southern California are affected by trash and that accessibility and proximity to roads greatly increases the amount of trash observed. Both urban and open space streams contain trash and the top three categories in each case were plastic, glass, and metal items. The most abundant items counted were single use plastic bags, polystyrene foam, single use plastic food wrappers, broken glass, and persistent plastic materials. In all, the top five items constituted 60% of the trash collected across southern California streams. The regional assessment of trash was made possible by a multi-partner collaboration involving Stormwater Monitoring Coalition member agencies, including all major southern California stormwater programs and the three southern California Regional Water Quality Control Boards, the State of California Surface Water Ambient Monitoring Program, the California Department of Fish and Wildlife, and the Council for Watershed Health.

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ESTUARINE IMPACTS ON CORAL REEF HEALTH AND THE IMPLICATIONS FOR WATER RESOURCE MANAGEMENT IN SOUTHEAST FLORIDA

Development of sound management strategies is critical for conserving coral reef communities, particular in nearshore systems subject to increased human impacts. St. Lucie Reef in Southeast Florida is strongly influenced by freshwater discharges from the Indian River Lagoon, St. Lucie River, and its expanded watershed, including Lake Okeechobee. The overall watershed includes both natural drainages and water control structures designed to retain water during the dry season (December to April). During the wet season (May to November), increased precipitation and controlled releases result in estuarine discharges that persist for days, weeks, or months over the reef. This study was designed to assess the relative impacts of these discharges on water quality, coral health, and endosymbiotic dinoflagellate algae with coral tissues. For the dominant hard corals, *Montastraea cavernosa* and *Diploria clivosa*, relative health was quantified using coral stress gene expression microarrays, 16S rRNA gene-based bacterial community profiling of coral mucus, dinoflagellate density counts, and chlorophyll concentration. *M. cavernosa* exhibited variable expression of genes related to xenobiotics, pesticides, osmoregulatory stress, and symbiosis regulations. Coral mucus associated bacterial communities were dominated by alpha- and gamma-proteobacteria, differed significantly over time, and differed from bacterial communities found on conspecific corals in other Caribbean regions. The two coral species differed with respect to dinoflagellate density and chlorophyll *a* concentration. Ongoing work will assess coral health and benthic community responses to changing watershed management and water quality resulting from the Comprehensive Everglades Restoration Plan.

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ASSESSING THE INFLUENCE OF THE MURDERKILL ESTUARY ON THE DELAWARE BAY USING CONTINUOUS REAL-TIME BIOGEOCHEMICAL MONITORING

Since April 2012, the University of Delaware has operated a real-time water quality monitoring station at Bowers, Delaware, where the Murderkill Estuary meets the Delaware Bay. The Land Ocean Biogeochemical Observatory (LOBO) instrument (Hach-Hydromet) is deployed under a public dock adjacent to a USGS gauging station (01484085), in collaboration with the Kent County Board of Public Works, Delaware's Department of Natural Resources and Environmental Control, and the U.S. Geological Survey (USGS). Every hour the LOBO measures salinity, temperature, pressure, dissolved oxygen, turbidity, chlorophyll, CDOM (colored dissolved organic matter), nitrate and phosphate. Real-time preliminary data are available on the web (kentcounty.loboviz.com). During ebb tide, the LOBO samples water originating in the Murderkill; at flood tide, the LOBO samples Delaware Bay water. Besides hourly and longer term monitoring of water mass and particle exchange between the Murderkill and Delaware Bay, we can now begin to assess the influence of particles, NO3-, and PO43- loading on the Delaware Bay, and use the assessment for management solutions. Since the Murderkill Estuary is turbid, and, as a consequence, has low net primary production, most of the point and non-point source nutrients are delivered conservatively to the Delaware Bay. Nitrate concentrations at Bowers at slack ebb tide are often higher than 60 μM, compared to less than 5 μM during slack flood tide. In the spring and summer, nutrients from the Murderkill probably help stimulate Delaware Bay primary production, as observed from dissolved oxygen supersaturation (110-130 %) measured by the LOBO at flood tide; supersaturation only occurs at flood tide, during the day, and when turbidity is low. In the summer, the Murderkill River and other similarly turbid tributaries are probably important nutrient sources that stimulate primary production in the Delaware Bay.

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OYSTER SPAT RESPONSE TO HYDROCARBON CONTAMINATION FOLLOWING THE *DEEPWATER HORIZON* OIL SPILL IN BARATARIA BAY, LOUISIANA

The *Deepwater Horizon* oil spill in April 2010 threatened productive oyster reefs in Barataria Bay, Louisiana. Shoreline Cleanup and Assessment Technique (SCAT) data revealed that parts of the bay were more heavily oiled than others and while cleanup occurred shortly after the spill, the long-term effects of hydrocarbon contamination on eastern oysters (*Crassostrea virginica*) remain relatively unknown. To test for long-term differences in oyster recruitment between heavily oiled and unoiled sites following the spill, two oiled sites, Grand Terre and Bay Jimmy, and two control sites, Grand Isle and Hackberry Bay, were sampled monthly during 2012 and 2013. These four sites were chosen along a salinity gradient to provide a high and low salinity location for the oiled and control sites. Ten ceramic tiles were deployed at each site and collected one month later; the number and percent cover of oysters, barnacles, and other sessile organisms were quantified. Preliminary data from 2012 indicate that there is no difference in oyster recruitment between oiled and control sites that can be attributed to long-term hydrocarbon contamination in the bay. To further assess how hydrocarbon contamination affects the oyster community in Barataria Bay on a shorter time scale, a lab study was conducted in which adult oysters and oyster spat were exposed to either low or high concentrations of oil at low or high salinity levels, comparable to those at the study sites. Prior studies have evaluated adult and oyster larvae responses to various salinity levels and oil concentrations, yet few have focused on oyster spat. The observed condition indices and mortality rates suggest that oyster spat respond differently to salinity and hydrocarbon contamination levels, and this response may be an important consideration for oyster protection and restoration efforts during the next major oil spill.

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THE "MISSING" LINK: RELATIONSHIP BETWEEN MACROFAUNAL INVERTEBRATE POPULATIONS AND SEDIMENT PARTICLE SIZE OFF SAN DIEGO, CALIFORNIA

It has been well-established that sediments influence macrobenthic invertebrate (macrofauna) assemblages in marine communities off Southern California. Fine sediments (silt, clay) typically increase with depth; thus, coarser, sandy sediments characteristic of the inner continental shelf transition to a mix of sand and fine sediments on mid- to outer shelves, with the highest percentage of fine sediments occurring on the upper slope. As fine sediments increase with depth, invertebrate species richness and abundance change. Greatest species richness and abundance occur on inner and mid-shelf strata, and then progressively decrease from the outer shelf to upper slope. To characterize this known link, multivariate statistical analyses were conducted using regional data collected at 161 shelf to slope stations (9-448 m) by the City of San Diego from 2009–2012. PRIMER software was used to generate resemblance matrices for sediment particle size and macrofaunal abundance data, and cluster analyses conducted from which major, ecologically relevant cluster groups were interpreted. A RELATE test was used to compare the pattern of rank abundance in each resemblance matrix, and a BEST test used to determine which sediment subfractions were the best explanatory variables for similarity between the two matrices when significance was found. Overall, 13 macrofaunal and 9 sediment cluster groups were interpreted, with cluster groups from both data sets segregating by either depth or geography. The significant similarity in pattern identified using RELATE was evident through cluster analyses, with stations in both dendrograms clustering similarly. Relative abundances of clay, very fine silt, fine silt, medium silt (all considered fine sediments) and fine sand were the sub-fractions most highly correlated to patterns in macrofaunal abundance. Descriptive metrics calculated for macrofaunal and sediment cluster groups allow for unparalleled integration of these related data sets.

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BIOPHYSICAL FEEDBACKS IN TIDAL CREEK FORMATION

Salt marshes provide many ecosystem services to humanity, but are threatened by sea-level rise. Many studies examining the impacts of sea-level rise neglect the role of the marsh biota. In some areas, sea-level rise is leading to rapid headward erosion of marsh creeks, which are characterized by dense crab populations. The herbivorous crab, *Sesarma reticulatum*, is common at creek heads but rare on the marsh platform (>35 vs. ~1 crabs/^{2}). These crabs can have significant effects on marsh vegetation and soil. *Sesarma* herbivory and burrowing activities in laboratory experiments provide plausible mechanisms connecting crabs to creek growth. Whether crab herbivory and burrowing mediate creek growth in the field, however, is unknown. In addition, the mechanisms driving high *Sesarma* densities at creek heads are currently unclear. We are conducting two field experiments to directly link *Sesarma* to creek growth. In the first experiment, we are removing *Sesarma* at two pairs of creek heads using pitfall traps to test the hypothesis that *Sesarma* facilitates creek growth by bioturbating sediment and removing stabilizing vegetation. The removal creek had significantly more standing *Spartina alterniflora* biomass (~150g/^{2}) than the control creek (~50g/m^2). In the second experiment, we are mimicking the high water flow typical of natural creeks using 3" PVC pipes to test the hypothesis that hydrological conditions at creek heads stimulate *Sesarma* recruitment. The treatment with the PVC pipe had significantly more burrows (~90 burrows/^{2}) than the controls (~40 burrows/^{2}). These results suggest that there are reciprocal feedbacks in creek formation. Hydrological conditions at creek heads drive the recruitment of *Sesarma* crabs. In turn, crab herbivory and burrowing remove plants and loosen soils, leading to rapid creek growth.

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RESPONSE OF MICROBENTHIC COMMUNITIES OCCUPYING SHALLOW MARINE ECOSYSTEMS IN MARQUESAS KEYS AND SOUTH FLORIDA ESTUARIES (FLORIDA BAY AND BISCAYNE BAY, USA) TO THE RECENT CLIMATE CHANGE

Intensification of climate change over the last century changed the character of shallow water ecosystems in the Florida Keys National Marine Sanctuary and the semi-enclosed South Florida estuaries. In order to develop proper management policies for the region, it is vital to obtain scientific evidence of past ecological conditions. The decadal to centennial records of subfossil diatoms obtained from sediment cores collected in Marquesas Keys, Florida Bay and Biscayne Bay, were used to study the magnitude of environmental change caused by climate variability over the last few centuries. A cumulative sum of standardized deviations technique (Z-Cusum) and a parametric method based on sequential t-test analyses of regime shifts (STARS) were used to identify changes in the percent diatom assemblage similarity between consecutive samples in each core. These analyses revealed that in most of the cores obtained from Marquesas Keys and the estuaries major shifts in diatom assemblage structures occurred in the last ~60 years. Additionally, the magnitude and the rate of diatom assemblage restructuring increased since the mid-1900s. These changes suggest that environmental conditions alterations are occurring more rapidly now than in the past. Smaller magnitude changes in all cores often coincided with severe drought periods that developed during cold phases of El Niño Southern Oscillation (ENSO), Atlantic Multidecadal Oscillation (AMO) and Pacific Decadal Oscillation (PDO), or when AMO was in warm phase and PDO was in the cold phase.

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DIFFERENT DEVELOPMENTAL RESPONSES OF BIVALVE LARVAE TO PCO2, PH, AND SATURATION STATE

Acidification of coastal and estuarine waters may be driven by the increase in atmospheric pCO_2 as well as other processes that can lower saturation state, such as freshwater delivery. In these habitats the direct relationship between pCO_2 and saturation state can decouple, and carbonate chemistry can change in unique ways not generally considered in acidification experiments. We utilized a novel experimental approach to evaluate the carbonate system parameter of greatest importance to the early development of two species of bivalve larvae, *Crassostrea gigas* and *Mytilus galloprovincialis*. The experimental treatments were designed orthogonally with respect to pCO_2 and saturation state; however we still can evaluate pH pseudo-independently of the other factors. We measured the percent of larvae that developed normal shells 48 hours following fertilization, and shell height of the normally developed larvae. Both species show acute responses of early larval shell development to saturation state, but not pCO_2 or pH, and follow a threshold type response. The two species appear to have slightly different sensitivities; both show strong decreases in normal shell formation near undersaturation while a few individual larvae in both species develop normal shells under mildly corrosive conditions. Shell height of the normally developed larvae was also dependent on saturation state, with sizes ~25% larger at the highest saturation states. Our results only capture acute effects on early developing larvae, and additional experimental work is needed to extrapolate to other species. Our findings highlight three important aspects for future ocean acidification research: 1) organism responses to changing coastal carbonate chemistry should be evaluated carefully, 2) experimental work on organism responses should account for the entire carbonate system, and 3) monitoring efforts should be sufficient to constrain the entire carbonate system in marine and estuarine waters.

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IS SEAGRASS THE SOLUTION? THE EFFECT OF EELGRASS ON EASTERN OYSTER BIOMINERALIZATION

Rising atmospheric CO2 levels are causing the pH of coastal waters to decrease. Acidification especially affects organisms that form calcium carbonate skeletons by causing the dissolution of calcium carbonate and reduced rates of calcification. For some calcifying organisms these effects are increased for juveniles, or smaller organisms due to differences in morphology and shell chemistry. The uptake of dissolved CO2 through photosynthesis can potentially reduce the effects on calcified organisms, by raising the pH. Our study examined the effects of the seagrass Zostera marina (eelgrass) on the calcification of two different sized Crassostrea virginica (eastern oyster) when the seagrass and oysters were grown together in microcosms. Daily analyses of pH, total alkalinity, and calcite saturation state were used to measure differences in biomineralization of shell. Zostera marina significantly raised the pH and increased the saturation state of calcite while increasing uptake of CaCO3 in oyster of both size class. Our study suggests that seagrasses and other

submerged aquatic vegetation have the potential to ameliorate the effects of acidification on calcification rates in shellfish.

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IMPACT AND RESILIENCE OF SALT MARSH BENTHIC COMMUNITIES AFTER THE DEEPWATER HORIZON OIL SPILL

The Deepwater Horizon oil spill in 2010 resulted in direct oiling of salt marsh habitat across the Gulf of Mexico, causing mortality of benthic organisms and accelerated marsh erosion. However, little is known about the long-term chronic effects of oil exposure on salt marsh benthic communities, and how these effects may combine with other environmental factors that structure benthic communities, such as salinity, sediment properties, and degree of tidal inundation. We conducted a field study of salt marsh benthos, sediment properties, and sediment oil residues at six oiled salt marsh sites and six paired unoiled reference sites across three regions in coastal Louisiana. Densities and composition of epi- and infauna varied by site, region, salinity, sediment type, and vegetative cover, but were not significantly different between oiled and unoiled marshes. These findings point toward the need for multivariate approaches to detect oil pollution impacts amongst many other changing environmental factors, and the need for time series data to elucidate magnitudes of impacts and processes of recovery. Three years after the original oil spill, petroleum hydrocarbons were still elevated in the sediments of previously oiled marshes, suggesting that burrowing or deposit feeding animals may be chronically exposed to oil at these sites, or that storm events will result in acute re-exposure of oiled sediments.

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COASTAL OCEAN ACIDIFICATION: THE OTHER EUTROPHICATION PROBLEM

The combustion of fossil fuels during the past century has increased levels of CO_2 in the world's oceans, decreasing ocean pH and leading to 'ocean acidification'. The continuation of these processes this century will alter the growth, survival, and diversity of marine organisms that synthesize $CaCO_3$ such as shellfish as well as non-calcifying animals such as larval finfish. Excessive nutrient loading into coastal ecosystems promotes algal productivity and the subsequent microbial consumption of this organic matter lowers oxygen levels and contributes toward hypoxia. A second, often overlooked consequence of microbial degradation of organic matter is the production of CO_2 and reduction in pH associated with that process. To assess the potential for eutrophication-driven acidification, the concentrations of dissolved oxygen, CO_2, and pH were both horizontally and vertically profiled in numerous eutrophic, urban estuaries surrounding the New York metropolitan area during the onset and demise of hypoxia. In Long Island Sound, the nation's third largest estuary, acidification of bottom waters commenced in May and persisted into the fall. In regions of Jamaica Bay, NY, receiving significant loads of sewage discharge, the entire water column was found to be acidified during spring, summer, and fall. Both estuaries displayed levels of CO_2 and pH not expected in the world's surface oceans until the late 22nd century (>2,000 µatm, < 7.5 units, respectively). Given these conditions were present during the finfish and shellfish spawning seasons, and given these levels of CO_2 and pH have been shown to inhibit the growth and survival of larval finfish and shellfish, coastal ocean acidification in eutrophied estuaries may be currently altering the ability of these ecosystems to support robust fisheries. The compounded effects of ocean acidification driven by the forcing of atmospheric CO_2 may exacerbate these impacts in the future.

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BUILDING COMMUNITY IN MARINE BIOLOGY CLASSES: COMBINING AUTHENTIC RESEARCH AND SERVICE-LEARNING

Undergraduates involved in independent research receive a competitive edge so that at graduation they can boast having technical experience and oral/written communication skills. However, most universities do not have enough faculty to mentor all STEM students one-on-one. Likewise, undergraduates have limited opportunities to share their research with the community-at-large. To deal with both of these issues, I have created a class where all students participate in authentic research and communicate their findings to both scientifc and K-12 public school audiences. Students in my upper-division, elective Marine Biology course showcase what can be achieved. In this 25-person class, all individuals collaborated on research projects over the course of the semester. Students selected from topics that were feasible within time and budget constraints, and would add to the current literature. Results were presented at our university-wide Showcase of Undergraduate Research Excellence. As part of the class's service-learning pedagogy, students were connected with public school educators. UCF students developed a plan to visit the classroom where they shared information on their topic (i.e. invasive species, ocean acidification) and how their research fit into better understanding this topic. A related hands-on activity was also developed and presented at the school. The final product was presented at our University's annual Service-Learning Showcase.

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SEA LEVEL RISE: FIELD SIMULATIONS WITH THE INTERTIDAL OYSTER *CRASSOSTREA VIRGINICA*

The eastern oyster *Crassostrea virginica* is an ecologically and commercially important species along the western Atlantic seaboard and Gulf of Mexico. With the goal to model the impact of sea level rise on intertidal *C. virginica*, we deployed 10 oyster ladders in Apalachicola Bay, FL and 10 in Grand Bay, MS. Each ladder contained 36 oyster shells and 1 sediment trap at each of 5 intertidal heights (range: 30 cm increments from near mean low water to near mean high water). Hence, inundation time was our proxy for sea level rise. Oyster ladder data being collected for our model includes: oyster recruitment, oyster growth rates, oyster orientation, reef thickness, biodiversity of sessile and motile species, sediment loads, total suspended solids, and abiotic variables. Significant differences were found with oyster recruitment - numbers peaked at intermediate submersion times while growth was greatest with the longest submersion time. Barnacles were the primary spatial competitor, and sediment accumulation was greatest closest to the benthos. Our data and subsequent model will be essential to resource managers and restoration specialists working to protect shellfish reefs over the long-term.

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TRACKING ATLANTIC TARPON MIGRATION AND HABITAT UTILIZATION WITH CHEMICAL SIGNATURES IN SCALES: A NON-LETHAL APPROACH

Atlantic tarpon, Megalops atlanticus, are large migratory elopomorph fish that frequent coastal and inshore waters of the tropical and subtropical Atlantic Ocean, and often inhabit brackish lagoons and freshwater tributaries. Despite the intensity of management and the economic importance of tarpon, many aspects of its biology are poorly described including the frequency and duration of movements into low salinity habitats. We present results from a non-lethal method to help quantify movements between estuarine and offshore habitats of tarpon and their participation in coastal food webs using natural geochemical signatures in scales. We used (1) laser ablation ICP-MS to quantify Ba and Sr concentrations and (2) isotope ratio mass spectrometry for carbon and nitrogen stable isotope ratios to quantify chemical changes across growth increments in scales to determine if they reflect movement between estuarine and off shore habitats. Isotopic and trace element signatures showed distinct patterns that indicated both movement between estuarine and offshore habitats as well as ontogenetic trophic enrichment with age. Chemical signatures differed among regions, indicating some geographic separation among baseline signatures. Patterns in geochemical signatures also differed among individuals, suggesting that this method may provide a non-lethal alternative to geochemical signatures in otoliths for quantifying individual migration patterns. This approach is preferable for Atlantic tarpon and other highly protected species where traditional lethal techniques are unsuitable.

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INTEGRATED MODELING FOR WATER RESERVATION TO PROTECT FISH AND WILDLIFE IN ST. LUCIE RIVER AND ESTUARY

The estuarine oligohaline zone has great biological production but is sensitive to freshwater inflow and the position of the low salinity interface. In subtropical Florida, creation of coastal storage reservoirs offers a practical restoration option that helps attenuate high discharge in the wet season and provides minimum freshwater inflow to maintain low salinity zone nursery conditions in the dry season. Optimal hydrology and isohaline distributions for ecosystem restoration in the St. Lucie River and Estuary provided the rationale for applying a suite of models that simulate freshwater inflow, reservoir operation, and downstream salinity to quantify the availability of flow for the protection of fish and wildlife in the estuary. Flow distribution targets relative to salinity habitat performance measures were used to guide environmental operation of reservoirs proposed in the Comprehensive Everglades Restoration Plan to achieve the ecological restoration targets. Results indicate that linked watershed and estuarine models along with resource-based ecological restoration targets provide effective management tools to predict preferred

flow and salinity conditions for improving the overall health of south Florida estuarine ecosystems.

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SUMMER NUTRIENTS REMOVAL AND BIOLOGICAL CARBON UPTAKE RATE INDICATED BY THREE END-MEMBER MIXING MODEL IN THE CHANGJIANG RIVER PLUME

DIN, PO_4^{3-}, SiO_3^{2-} surface distribution showed eutrophic water of Changjiang River (Yangtze River) and oligotrophic offshore seawater mixing pattern during the summer cruise in 2006. Transects data suggested that Changjiang Diluted Water (CDW), Kuroshio Surface Water (KSW) and Taiwan Warm Current (TWC) played prominent role in regulating the estuarine nutrients behaviour, along with the biological accumulation and regional nutrients structure anomaly thereafter in the upper ocean. Hence, based on conservative temperature and salinity, a three end-member (Changjiang River Plume water (CRPW), Outer-shelf Surface Water (OSW) and Outer-shelf Deep Water (ODW)) mixing model was introduced to check the end-member composite contribution to biological activity and access nutrients consumption defined as deviation from the theoretically conservative mixing within top 5 m depth. End-member composite suggested the CRPW and OSW mainly offered DIN and SiO_3^{2-} to maintain Chl a increase and O_2 releasing, while ODW fraction indicated that consumed P mainly come from outcropped upwelling water. Nutrients uptake and excess O_2 ratio, ΔDIN:ΔP:ΔSi: ExcessO2=26±10: 1: 37±13: 148±69 were calculated based on the nutrients uptake in top 5 m depth samples with excess O_2 >10 μmol L^{-1}. Furthermore, a simple top 5 m thickness box model in the studied area was presented to estimate biological carbon uptake rate based on nutrients deviation under several assumptions. Biological carbon uptake rate was deduced with the aforementioned nutrients uptake ratio and assumed Redfield ΔC:ΔDIN ratio (6.6) after nutrients deviation inventory and residence time were estimated. The rates derived from DIN, P and Si deviation were 225 mgC m^{-2} d^{-1}, 231 mgC m^{-2} d^{-1} and 238 mgC m^{-2} d^{-1}, respectively, although which might be underestimated due to box model restrictions, falling within reported observed summer primary production range in Changjiang Estuary and adjacent East China Sea.

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DISPERSAL OF FINE-GRAINED SEDIMENT ALONG THE CALIFORNIA COAST – LINKING SCIENCE TO MANAGEMENT

Sediment and its beneficial reuse is an important consideration for natural resource and coastal managers in protecting and restoring critical habitat, especially in the face of highly altered natural systems and a changing climate. The observations from the 2008-2009 USGS "Fate and Transport" studies suggest that fine sediment transport directions and rates respond strongly to ocean conditions including wave height and direction and coastal currents; the majority of fine sediment was rapidly transported away from the placement site. This study explores the patterns and processes of fine-grained sediment dispersal from nearshore settings, including our ability to model these processes numerically. Results from this study can inform management, both at the place-based Tijuana Estuary, and for practitioners elsewhere who manage for fine-grained sediment.

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LESSONS LEARNED FROM AN ECOSYSTEM-BASED MANAGEMENT APPROACH TO EVALUATION OF WETLAND RESTORATION ALTERNATIVES FOR THE ELKHORN SLOUGH ESTUARY, CALIFORNIA

Ecosystem-based management (EBM) is the dominant paradigm, at least in theory, for coastal resource management. However, there are still relatively few case studies illustrating thorough application of principles of EBM by stakeholders and decision-makers. At Elkhorn Slough, a California estuary, an EBM initiative was launched in 2004. A panel of decision-makers including representatives of organizations with regulatory or jurisdictional authority over the estuary evaluated large-scale restoration alternatives developed to restore "more natural" hydrological conditions to this highly altered system. In 2012, the decision-makers chose preferred alternatives and mapped out a plan for wetland restoration in the estuary. We report on the lessons learned from this application of EBM to an estuary. For instance, we encountered challenges during interdisciplinary evaluations, because the values and approach of fields such as hydrology, biology, and environmental economics are so different. The biggest conflicts among stakeholders in this EBM initiative did not occur between advocates of "take" and "no take", as is common for fisheries-related management issues, but rather among highly engaged environmentally-committed stakeholders who agreed on the intrinsic value of estuarine biodiversity as the primary goal, but disagreed on specific restoration targets – thresholds of tidal range, salt marsh acreage, or nutrient concentrations. New science conducted as a part of the EBM process led to paradigm shifts about the relative role of different human alterations, including increased recognition of the role of eutrophication in this system. The changes in understanding from recent science and the inherent difficulty in making long-term predictions support taking a precautionary approach to strategic planning. Incorporating new science and diverse perspectives resulted in an ongoing, robust process for creating a roadmap for the future of Elkhorn Slough.

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RHYTHMS OF LOCOMOTION EXPRESSED BY FREELY MOVING HORSESHOE CRABS, *LIMULUS POLYPHEMUS*, IN THE GREAT BAY ESTUARY

The main purpose of this study was to determine the types of biological rhythms horseshoe crabs express in their natural habitat. A secondary goal was to determine if their overall activity, and depth preferences, change over the course of the year. A total of 20 adult horseshoe crabs, 11 males and nine females, were fitted with Vemco V9 ultrasonic transmitters and released in the Great Bay estuary in 2010-2011. The tags transmitted acceleration and depth data every 3-5 minutes from June until December, and then from March to May the following year. Transmissions were detected and logged with VR2 receivers moored throughout the estuary. Accelerometer data were used to assess when animals were active and thus determine if the horseshoe crabs were expressing tidal or daily rhythms. These data were also used to determine their overall daily activity levels during the months the transmitters were active. Depth data were also used to determine if their depth preferences changed during the year. We discovered that, as expected, most horseshoe crabs expressed tidal rhythms. However, despite being continuously exposed to natural tide cycles, some exhibited daily rhythms. In addition, there was a tendency to move into deeper water and become less active as water temperatures cooled in the fall, and then move up into the estuary and become more active as water temperatures warmed in the spring. This study demonstrates the utility of accelerometer transmitters for studying the patterns of activity expressed by aquatic species and also sheds light on the seasonal patterns of locomotion expressed by freely moving horseshoe crabs in their natural habitat.

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COLLABORATIVE SCIENCE: ENGAGING END USERS AND SCIENTISTS TO BUILD MUNICIPAL CAPACITY FOR COASTAL STORMWATER MANAGEMENT

Collaborative end-user science brings the intended users of science into the research process so their perspective can inform problem definition, project implementation, and ultimately, the practical application of science. Integration of the intended users into each stage of a research project acknowledges the goals of both users and researchers, and supports an integrated science that is relevant, applicable, and technically rigorous. Green Infrastructure for Coastal Communities is a collaborative science project that seeks to inform municipal decision makers by explicitly addressing both science and collaboration goals. Stormwater runoff is a leading cause of water quality impairment in the US and around the world. One of the most promising methods of mitigating impact from stormwater is the adoption of Green Infrastructure practices, where natural, engineered, cultural, and ecosystem elements are used to restore hydrology and improve runoff water quality. Adoption of these practices requires support from decision makers at the municipal, regional and state level. This project builds municipal capacity in coastal watershed communities for Green Infrastructure by directly engaging local and regional stakeholders with the project team in all phases of a research project. The Project team includes both technical and collaborative experts, and works in coordination with a project advisory board comprised of community decision makers and other stakeholders. The project has quantitative research goals in engineering, watershed modeling, and collaborative engagement. We will discuss end user participation in each phase of the project, from problem definition, proposal submission, and implementation, and will review lessons learned. This process provides deep engagement and commitment from the users, but requires significant time and resources to implement.

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NUTRIENT EFFECTS ON *SPARTINA ALTERNIFLORA* AND *AVICENNIA GERMINANS*: IMPLICATIONS FOR COMPETITION IN A MARSH-MANGROVE ECOSYSTEM

Increasing temperatures are predicted to cause coastal community species shifts. *Avicennia germinans* (black mangrove) can out-compete salt marsh species with its taller canopy height, but expansion is limited by freezing events. Predicted warmer temperatures in the northern Gulf of Mexico may facilitate *Avicennia* expansion into *Spartina alterniflora* (smooth cordgrass) dominated salt marshes, thereby promoting a foundation species shift. Climate-induced transformations can be further exacerbated when paired with anthropogenic stressors such as nutrient input. Our objective was to determine how increased nutrient input would alter competitive dynamics *in situ* between *Avicennia* and *Spartina*. In Port Aransas, TX, USA we demarcated 22 4-m^2 plots in established *Avicennia* and *Spartina* mixed stands; we enriched half (n=11) with slow-release fertilizer. After 28 months of continued enrichment, *Avicennia* leaf total nitrogen content and photosynthetic activity were 31% and 13% higher, respectively, in enriched plots compared to ambient plots; *Spartina* leaves showed no significant nutrient effect. *Avicennia* maximum height was 38% higher in enriched plots; *Spartina* height showed no significant difference. Additionally, the difference between *Avicennia* and *Spartina* maximum height was four times greater in enriched plots. *Avicennia* displayed much stronger responses to enrichment than *Spartina* did, suggesting that *Avicennia* may be able to uptake and assimilate nutrients better than *Spartina*. The competitive edge is then augmented as *Avicennia* canopy height increases. Mangroves' ability to competitively displace salt marsh grasses is primarily attributed to its taller morphology. These data suggest nutrient enrichment facilitated a greater competitive edge for *Avicennia*. Therefore, increased anthropogenic nutrient input within this transitioning ecotone lends a greater potential for faster competitive exclusion of *Spartina*.

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LIVING SHORELINES: HOW MUCH COASTAL ENGINEERING DO YOU NEED?

A living shoreline may best be described as a natural approach to bank and shoreline stabilization that uses plants, sand, and some rock to protect the shoreline while maintaining valuable habitat. Living shorelines often incorporate structural and organic materials to facilitate natural shoreline processes while providing shore- and marine-based habitat; stone, sand fill, reefs, and vegetation are commonly used to achieve these goals. While the terminology is relatively new, coastal engineers have for many years used the living shoreline approach, particularly for smaller projects along sheltered shorelines. In recent years, however, the living shoreline concept has focused more on coastal ecology than it has on addressing the local wave, tide, and sand transport environment—the physical coastal processes—and the requisite coastal engineering design needed to ensure continuity of the physical processes and ecological benefits. Indeed this trend is likely a result of the growing popularity of living shorelines and the lack of widely available coastal engineering guidance on their successful design and implementation. Furthermore, the professional practice and research communities of coastal ecology and coastal engineering have intersected on relatively few occasions. If successful alternatives to building bulkheads, revetments, and seawalls will ever flourish, these two areas of practice and research must make concerted efforts to collaborate on maximizing ecological and engineering benefits on a site-specific basis. This presentation will highlight examples of living shorelines projects that have succeeded, as well as some that have not, in an effort to answer the question posed in the abstract title: how much coastal engineering do you need? Progress on the development of a living shorelines decision support toolkit, which provides specific coastal engineering guidance for their design, will be summarized.

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SALT MARSH MIGRATION FROM SEA-LEVEL RISE IN PRINCE EDWARD ISLAND, CANADA

Coastal ecosystems that support waterfowl habitat are under threat from coastal development and natural changes as a result of rising sea-levels throughout Maritime Canada. In order to determine the best management and possible land acquisition practices to ensure suitable salt marsh habitat in the future, GIS analysis have been applied to five representative coastal areas in Prince Edward Island. This study site was selected because the entire island is covered by orthophotos of 1968 and 2010 as well as a lidar derived DEM at 1.5 m resolution. The lidar DEM was modified to include hydraulic pathways connecting the ocean to inland low lying areas where culverts and small bridges exist but were not represented in the original DEM. The 1968 and 2010 photos were interpreted to map the salt marshes and calculate their areas. Tidal predictions for each of the five sites were used to define the elevation of mean sea-level (MSL) and the highest high water, large tide (HHWLT) which defines the typical elevation range for salt marsh vegetation to grow. The prediction of salt marsh from the lidar DEM for this range of elevation (MSL-HHWLT) was compared to that interpreted from the 2010 orthophotos. A relative sea-level rise (SLR) of 1 m/century was used to linearly project the elevation boundaries into the future for 2050, 2100, and 2200. These elevation ranges where then used with the DEM to calculate the new potential areas of salt marsh for these periods. The area of salt marsh was then calculated and compared between years. This type of analysis can be used as a management and planning tool to determine what land areas are most suitable for acquisition in order to preserve salt marsh habitat today and into the future. In addition to evaluating the salt marsh area in the future, adaption measures can be identified that impact salt marsh habitat such as the location of future culverts to ensure adequate tidal flushing for newly inundated areas.

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CAN A FRINGE MARSH AND EELGRASS SYSTEM SURVIVE CHANGING HYDRAULIC AND ANTHROPOGENIC IMPACTS WITHOUT INTERVENTION?

Engineering with nature is a concept that has been used for many years. The need to balance protection of coastal and upland infrastructure while maintaining wetland resources is often a challenge. The project described is the shoreline of a world-class golf course located in Pleasant Bay in the Town of Chatham, MA. The golf course has approximately 2.3 km of shoreline that consist of high coastal banks, coastal beaches, high and low salt marshes, and offshore eelgrass beds. The coastal banks of the golf course have been subjected to increasing tides and storm surge associated with the formation of the two new inlets that formed when the fronting barrier island was breached in 1987 and then in 2007 which increased the tidal range thus subjecting the coastal banks, fringing marshes, and nearshore eelgrass to increased storm surge and wave activity. The golf course is a typical landlocked urban golf course that is land poor so that relocating threatened Tees or realigning the holes is not possible. The project objective is to provide protection to the golf course through a series of soft engineering solutions and beach nourishment. However, placing sand on the beach has the potential of smothering the fringing marsh and covering the adjacent eelgrass beds. The project established a comprehensive monitoring program to monitor the effects of the shore protection on the fringing salt marsh and the offshore eelgrass beds. One of the objectives was to allow the system to adjust/adapt naturally without engineering intervention. The results of the first two years of monitoring data show that there were increases in the high marsh and losses of low marsh and the adjacent eelgrass beds. The paper will present the data and discuss the impacts of the restoration project, the changing hydrodynamic conditions, and the systems ability to naturally adapt to the changing conditions.

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CURRENT- AND WAVE-DRIVEN FLOW WITHIN POLYCULTURAL VEGETATED CANOPIES

While researchers have studied water flow through natural and artificial vegetated canopies with a wide range of element morphologies and densities, most canopies under investigation have either been reported as or modeled after monocultures – communities composed of only a single species. Field survey results from a shallow Florida Bay seagrass meadow highlighted a more diverse benthic landscape. These polycultural communities and others like them - though often defined by a single dominant canopy member - are frequently composed of a mixture of both plant and algal species. Different species were found to occupy distinct vertical niches within the canopy space. Strap-like seagrasses defined the upper portion of these canopies (the upperstory) while broad, bushy algal species were found concentrated closer to the bed (the understory). To study the hydrodynamic implications of this dual-story canopy structure, model polycultural meadows were installed in a laboratory current-wave flume and exposed to a battery of unidirectional and oscillatory flows. Mean and fluctuating velocities above and within each canopy were measured using an acoustic velocimeter. Velocity statistics were used to determine vegetation-induced flow attenuation. Nearbed mean and root-mean-squared velocities were markedly reduced in those canopies with understory elements, an outcome that is of particular interest in the oscillatory flow cases. As found in earlier studies, the upperstory-forming species exerted little resistance to wave-driven fluid motion. Experimental results also compared favorably to predictions from a momentum balance model, itself explicitly reformulated to account for vertical canopy heterogeneities. These findings suggest that accurate prediction of sediment transport, propagule dissemination, and effective bed roughness for polycultural vegetated shallows depends on fully characterizing community composition and its attendant impacts on vertical canopy structure.

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RESPONSE OF A SPARTINA PATENS-DOMINATED OLIGOHALINE MARSH TO NITROGEN ENRICHMENT IN COASTAL NORTH CAROLINA, USA

Coastal marshes are highly productive ecosystems that play a significant role in the global carbon budget. Anthropogenic alterations to coastal landscapes can significantly impact these marsh ecosystems, though the actual loss of ecosystem functioning may depend on the type of marsh being impacted. Nitrogen loading into coastal environments has accelerated with increased use of fertilizers for agricultural production. Previous work has demonstrated that some marsh plants respond to nitrogen inputs by allocating more biomass into aboveground stems and leaves while reducing belowground biomass. These changes could diminish the carbon storage capacity in coastal marshes while also making them more susceptible to rising sea levels. The goal of this study was to fertilize plots in a Spartina patens-dominated oligohaline marsh with varying concentrations of urea applied throughout one growing season. Aboveground plant clippings and soil cores were collected to assess the changes in above- and belowground biomass among the treatments throughout time and to also assess tissue nitrogen and organic content. Litter bags were also placed at the soil surface of the experimental plots to determine rates of decomposition throughout the study. Neither aboveground nor belowground biomass was significantly affected by nitrogen application, and nitrogen assimilation into plant tissue did not vary across the treatments. Decomposition was also relatively similar across the treatments, though there were seasonal effects on litter loss. Our findings suggest that oligohaline marshes are not limited by nitrogen to the same extent as salt marshes, and may act as nutrient buffers to coastal waters without experiencing significant changes to native plant physiology.

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EXAMINING BIVALVE SHELLFISH PARTICLE REMOVAL EFFICIENCIES TO ENHANCE RESTORATION AND AQUACULTURE IMPLEMENTATION WITHIN NEW JERSEY WATERS

This research examines the interactions of bivalve shellfish native to New Jersey waters to determine what impact augmenting the population of a single species may have on the food availability for a community of bivalve filter feeders. A recent increase in the use of *Geukensia demissa* (non-harvested, intertidal mussel) in living shoreline initiatives, coupled with a revived interest in bivalve shellfish aquaculture within state waters (specifically *Crassostrea virginica*, the eastern oyster), has lead to the questioning of the effects augmenting single species populations may have on these organisms' interspecific feeding dynamics. For this study, a portable upweller system based upon systems common to bivalve shellfish aquaculture was developed and experiments were run at the New Jersey Aquaculture Innovation Center in Cape May, NJ. The upweller was built to house up to 24 silos, allowing for concurrent trials of various single species densities as well as mixed species experimental units. Water samples extracted from the basin inflow and the outflow of each silo were analyzed to quantify number of particles present as well as provide characteristics of each particle (e.g. diameter, elongation, circularity, etc.). The phytoplankton removal rates resulting from each individual species and mixed species trial were compared to assess for competition, synergism, or independent relations between the bivalves. Where possible, phytoplankton classification was identified to better determine food preferences of the study bivalves as well as the food availability within coastal waters.

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DECLINING SEDIMENTS AND RISING SEAS: AN UNFORTUNATE CONVERGENCE FOR TIDAL WETLANDS

The long-term stability of tidal wetlands is dependent on multiple, often non-linear ecogeomorphic feedbacks between sediment deposition, plant production, organic matter sequestration, and inundation. The availability of suspended sediments will be a dominant factor influencing the stability of tidal wetlands as sea levels rise. Land-use change in watersheds can alter the delivery of sediments from the landscape to the coastal zone. Watershed-derived sediments are a critical source of material supporting accretion in many tidal wetlands, and recent declines in wetland extent in several large river delta systems have been attributed in part to declines in sediment delivery. Little attention has been given, however, to changes in sediment supply outside of large river deltas. Changes in fluvial sediment supply from rivers draining to the East and Gulf Coasts of the U.S. over the past several decades were examined, and significant declines in suspended sediment concentrations (SSCs) over time were observed for 25 of 61 rivers. Declines in fluvial SSC were significantly correlated with increasing water retention behind dams, indicating that land-use change plays a role in declining sediment delivery. There was a regional pattern to changes in fluvial sediment, and declines in SSCs were also significantly related to rates of relative sea-level rise (RSLR) along the coast, such that wetlands experiencing greater RSLR also tend to be receiving less fluvial sediment. Tidal wetlands in the Mid-Atlantic, Mississippi River Delta, and Texas Gulf especially may become increasingly vulnerable due to rapid RSLR and reductions in sediment. These results also indicate that past rates of marsh accretion may not be indicative of potential future accretion due to changes in sediment availability. Declining watershed sediment delivery to the coastal zone will limit the ability of tidal marshes to keep pace with rising sea-levels in some coastal systems.

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RELATIVE INFLUENCE OF TOP DOWN AND BOTTOM UP CONTROLS UPON ESTUARINE PHYTOPLANKTON GROWTH AND COMMUNITY COMPOSITION

We examined the individualistic as well as combined effects of nitrogen availability and grazing pressure on estuarine phytoplankton growth and community composition in North Carolina's Neuse River Estuary. During each of three sampling events (June 2011, August 2011, March 2012), experiments were performed in which natural phytoplankton assemblages were exposed to nitrogen (as urea or nitrate) amendments and/or reduced grazing pressure (by filtering out zooplankton grazers). The effects of nitrogen additions and reduced grazing pressure varied depending on time of year and ambient environmental conditions. In June, when ambient inorganic nitrogen concentrations were near detection limits, nitrogen addition stimulated phytoplankton community growth. In August, when much higher inorganic nitrogen and phosphorus concentrations were present, only grazing reduction had a significant impact on community growth. Neither treatment had a significant effect on phytoplankton growth in March, when phosphorus appeared to be limiting based on in situ nutrient data and overall grazing pressure was likely minimal due to cooler water temperatures. Taxa-specific responses varied depending on treatments and time of year, suggesting potential effects of nitrogen and grazing on taxonomic composition. These experimental results will be combined with time-series field data to offer a broad overview of the relative role of nutrient and grazing availability in estuarine phytoplankton dynamics.

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VALIDATING A METHOD OF OTOLITH MICROCHEMISTRY TO IDENTIFY WATER-MASS ASSOCIATIONS OF LARVAL FISH IN AN UPWELLING REGION

Otolith microchemisty can be used to determine fish movement patterns and hind-cast geographic location or water-mass associations. Interpreting element:calcium ratios in otoliths, however, requires a thorough understanding of the mineralization process and natural variation in trace element concentrations. Our goal in this study is to validate a

methodology of otolith microchemistry analysis with the purpose of identifying water-mass associations of larval fish in a dynamic upwelling region, using three approaches for method development. First, we characterized seawater chemistry of upwelling-relaxation cycles across multiple years. Second, we experimentally determined the effect of temperature on trace element mineralization in otoliths of recently-settled rockfishes (*Sebastes* spp.). Finally, we reared juvenile rockfishes in a flow-through seawater system across an upwelling-relaxation cycle (~1 month), while simultaneously collecting sweater. This approach allows us to determine the accuracy of otolith chemistry in predicting short-term water-mass associations (~5 days). We found significant differences in the chemical signatures of water-mass types with a consistent barium:calcium signature for upwelled seawater. We found no significant effect of temperature on mineralization, indicating that temperature does not affect the utility of otolith chemistry as a proxy for seawater chemistry. In addition, we report the effectiveness of otolith microchemistry analysis as a tool to identify water-mass associations of rockfishes. We also present preliminary results of this method in identifying water-mass associations of rockfish during the process of settlement.

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THE IMPACTS OF PERENNIAL PEPPERWEED INVASION IN WETLANDS ALONG AN INUNDATION GRADIENT

Perennial pepperweed (Lepidium latifolium) is an aggressive, non-native weed that has invaded wetland and riparian areas throughout California, including the San Francisco Bay and Sacramento-San Joaquin Delta Estuary. At Rush Ranch, a brackish marsh in the San Francisco Bay National Estuarine Research Reserve, we examined the effects of perennial pepperweed on the surrounding non-invaded habitat along an inundation gradient from fully tidal to muted tidal and seasonal wetlands. Within a wetland isolated from tidal creeks, the presence of pepperweed significantly increased soil humidity and altered the diversity and composition of the surrounding plant and insect communities. In the marsh plain and marsh tidal creeks, the effects of perennial pepperweed were reduced due to constant inundation and soil saturation. In addition to altering abiotic and plant community parameters, the presence of perennial pepperweed also altered the biodiversity, abundance and community composition of associated invertebrate and insect communities. In the tidal marsh – terrestrial ecotone, abundance of ground-dwelling invertebrates increased in fall while canopy-dwelling invertebrates were most strongly impacted in the full tidal marsh. We hypothesize that these changes will lead to cascading impacts throughout the entire food web. Our data provide important information about the consequences of perennial pepperweed invasion and are paired with an on-going eradication effort to assist in making informed decisions regarding management and eradication of pepperweed within this marsh reserve.

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ASSESSING IMPACTS OF LAND USE ON COASTAL STREAM METABOLISM

Coastal streams connect terrestrial and estuarine ecosystems, however they remain relatively understudied compared to their inland counterparts. These streams are a conduit for nutrient and material loading and are susceptible to changes in land use, which can alter tributary loading and modify the processing and fate of nutrients and carbon within streams and the greater estuarine ecosystem. In order to assess the impact of land use on stream function, whole stream metabolism of five headwater streams of the New River Estuary, NC was measured using a one-station method. Watershed development of the streams ranged from 1 to 23% impervious cover. Whole stream metabolism was determined by continuously monitoring dissolved oxygen (DO) concentration and correcting for reaeration using two methods to estimate the oxygen reaeration coefficient (k), an integral element of metabolism calculations. Gross primary production increased with watershed development, although all five streams were net heterotrophic. However, large variability in metabolism calculations of these generally low flow streams could have obscured results. Low streambed gradients and ephemeral conditions common to coastal streams may preclude use of the one-station method and we are currently evaluating the two-station method with direct calculation of k using tracers. Other trends in productivity were also observed as a function of land use. Percent impervious cover of the watershed showed a negative relationship with CDOM and water column Chl-a was higher and more variable in watersheds with higher impervious surface. Increases in Chl-a concentrations of streams in impacted watersheds coincided with large diel excursions in DO (up to 10mg/L change daily), whereas less impacted streams had less pronounced diel patterns (< 1mg /L change). Historically, NC coastal streams were predominantly blackwater with high CDOM and low Chl-a, however it appears that increased impervious cover can alter trophic status.

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CLIMATE CHANGE CHARACTERISTICS OF WARMING AND WEATHER EXTREMES THE FOCUS OF INTRA- AND INTER-ANNUAL CHANGE IN WETLAND PLANT BIOMASS WITHIN THE MISSISSIPPI RIVER DELTA, LOUISIANA, AMONG OTHER ENVIRONMENTAL PARAMETERS

Riverine wetland plants are influenced by the quality of the flooding water particularly if floods are sheet flow and significant like those at the mouth of the Mississippi River in the State of Louisiana. Major water quality attributes include temperature, discharge, sediment load, and nutrient levels which are expected to vary seasonally and annually. This multi-decanal study focuses on the impact the waters of the Mississippi River have had on the wetlands within its senescing Belize delta. End-of-the-growing season (peak) above ground plant biomass plots have been collected (n = ~ 900) beginning in 1984 at permanent transects at three sites that began earlier to receive kinetic river flow from shoreline levee breaches. The sediment laden water flow produced two deltaic splays in a ~10 km^2 shallow <1 m deep pond formed earlier from wetlands over several decades as a result of three pervasive Louisiana coast-wide processes (sediment starvation, subsidence, sea level rise) which reduce substrate levels killing wetlands. River water quality data sources covering the early 25 yr sampling period of this longer study were analyzed and compared to the changes observed in the biomass data. Regressions show significant overall decanal increases in biomass (~100 g/m^2) and in Mississippi River temperature (~1^0 C). And regressions on biomass dynamics, both annual and decanal change, are significantly associated with especially the Spring river water qualities of discharge, temperature, and nitrate loading. Linked to the increase in river temperature is the start of the growing season each Spring that has become earlier on average over the decades which likely has lead to the measured decanal biomass increases at each of the three study sites. Change in the climate creating both warmer temperatures and greater extremes in weather events like spring floods and summer droughts must be the main forcers for much of the observed biomass patterns, both annual and decanal.

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THE SALISH SEA MARINE SURVIVAL PROJECT

Recent findings indicate a problem with early marine survival of salmon and steelhead in the shared marine waters of Washington State and British Columbia. Working with a multi-disciplinary group of scientists from over 20 federal and state agencies, tribes, and academia, with managers, and with funders from the public and private sectors, Long Live the Kings and the Pacific Salmon Foundation are facilitating the development of a joint United States and Canada research program, utilizing intellectual and capital resources from both countries to evaluate the causes of weak juvenile salmon survival in the Salish Sea marine environment (Puget Sound and the Strait of Georgia). Through the development of a comprehensive, ecosystem-based research framework; coordinated, standardized data collection; and improved information sharing, the Salish Sea Marine Survival Project will help managers better understand the relationship between juvenile salmon and the marine environment. Workshops were held in November 2012 to identify the critical elements of a US-Canada research program, and to identify potential ecosystem indicators for adult return forecasting. Scientists are using the workshop results to build upon preliminary research proposals and establish the research program. Over $1.5 million dollars has been identified for research activities that will begin in 2014. This presentation will provide an overview of the project; describe the methods employed for implementing a multi-disciplinary, ecosystem-based approach; and discuss the project's relevance to management and recovery efforts in Puget Sound and the Strait of Georgia.

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DEVELOPING A BLUEPRINT FOR AN INTEGRATED OCEAN MONITORING PROGRAM IN CALIFORNIA

Implementation of marine protected areas (MPAs) has increased dramatically in the last decade, fueled by practical demonstrations that this management tool can restore or protect species, habitats, and associated ecosystem services. As part of this process, the scientific theory underlying MPA network design has flourished. Scientific 'rules of thumb' to incorporate principles of connectivity and habitat representation have guided the implementation of MPA networks in many different coastal ecosystems. However, evaluations of MPA performance remain limited. A new statewide network of MPAs in California provides a ripe opportunity to reframe the way that we think about MPA monitoring and management. New MPAs in estuarine and nearshore coastal ecosystems regulate the extraction of living resources, but performance will be measured against a backdrop of many other system impacts, drivers and pressures. A deeper understanding of mechanisms by which MPAs function to conserve ecosystems in the face of water quality impairments and climatic changes is required. Moreover, with more than 100 MPAs along the coast, we need to better understand how to efficiently and cost-effectively track the effects of natural and anthropogenic impacts on ecosystem condition. We will present an approach for building a partnerships-based monitoring program that is efficient and cost-

effective. Rather than serving a single policy mandate, MPAs can play a critical role in an investment portfolio for our ocean health. But to do so we need to understand how to efficiently monitor and measure changes in ecosystem conditions and resilience in the face of multiple system impacts and drivers. Tackling this challenge is not only pertinent to California but also can provide a blueprint for an integrated ocean monitoring program that can be applied elsewhere.

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LANDSCAPE PLANNING FRAMEWORK FOR PROTECTION AND RESTORATION OF ESTUARINE HABITAT USING THE COLUMBIA RIVER ESTUARY ECOSYSTEM CLASSIFICATION

Restoration actions ostensibly contribute to a broad ensemble of ecosystem goods and services. The urgency and efficacy demanded in restoring threatened and endangered species habitat is not well served by ad hoc, opportunistic approaches to restoration and conservation. Strategic planning is critical, and especially so in the case of juvenile anadromous fishes that must adapt to complex land-margin landscapes with varying spatial and temporal habitat quality and quantity as they migrate from their natal watersheds to the coastal ocean. We are developing a landscape ecology-based approach to enable strategic planning for restoration and preservation of juvenile salmon habitat restoration in the Columbia River estuary. We use the hierarchical Columbia River Estuary Ecosystem Classification (CRE Ecosystem Classification) as the basis of an organizational 'framework' for identifying, recommending and selecting spatially-explicit restoration and preservation "targets," where these target sites in the estuary would provide the most likely benefit to specific at-risk Columbia River salmon stocks (ESU). Our goal is to integrate emerging scientific understanding of juvenile salmon habitat requirements and genetics in the estuary, landscape ecology conservation principles, existing geomorphic tools, and input from a knowledgeable external science advisory team. Using landscape metrics to quantify the structure, composition, distribution and organization of existing and potentially restorable fish habitat catena throughout the estuary, this framework will allow managers and practitioners to strategically identify and rank the types and locations of fish habitat catena of highest priority for restoration and conservation. This proactive, scientifically-based process is anticipated to advance more strategic restoration and preservation opportunities that can be effectively incorporated into Pacific salmon recovery actions.

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USING MECHANISTIC MODELS TO DERIVE WATER QUALITY CRITERIA

Nutrient pollution and resulting eutrophication is a significant cause of degraded conditions in estuaries and coastal waters around the world. In the US, the Environmental Protection Agency (EPA) is charged, along with state governments, with implementing provisions of the Clean Water Act (CWA) to prevent impairment of waters due to pollutants, such as excess nitrogen and phosphorus, and to restore waters already degraded by excess pollution. Among other functions, CWA regulatory programs define aquatic life and associated water quality goals (criteria and standards), plans for restoring impaired waters (TMDLs), and permit limits for point source dischargers that protect water quality (WQBELs). Water quality simulation models are increasingly a standard tool supporting all of these aspects of regulatory water quality management. In particular, models are widely applied for TMDLs and WQBELs. Recently, EPA applied mechanistic hydrologic, hydrodynamic, and water quality models together to propose numeric nutrient criteria for estuaries in the State of Florida, arguably the most extensive use of coupled hydrodynamic-water quality models for this purpose. Although many of the steps such as defining targets, selecting, configuring, calibrating, and interpreting models were common to other modeling applications, criteria development presented new requirements and challenges. We draw on lessons learned from EPA's recent work to compare and contrast the specific steps and requirements for applying mechanistic models to develop numeric nutrient criteria with the requirements for other regulatory modeling applications.

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COMMUNICATING CHESAPEAKE BAY SCIENCE AND MANAGEMENT

As an economic and tourism hub situated near Washington, D.C., Chesapeake Bay is one of the most studied and managed estuaries in the United States. Research and management of its water quality and living resources have evolved from physical-chemical to single species to multi-species to ecosystem-based over the last thirty years. In order to communicate the cutting-edge research and management that has occurred, federal, state, and local scientists have produced annual reports, numerous peer-reviewed papers, and comprehensive websites. However, a clearly articulated communications strategy was never proposed to synthesize the numerous and diverse studies. The history of the communication strategy used in the Chesapeake Bay area and the current thinking will be discussed, as well as examples of different communication strategies. Challenges, such as data synthesis and messaging, of a multi-state, multi-partnership communication strategy will be highlighted.

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EFFECTS OF SEX RATIO ON POTENTIAL SPERM LIMITATION AND FUTURE STOCK ABUNDANCE IN BLUE CRAB OF CHESAPEAKE BAY

The blue crab Callinectes sapidus is an important commercially harvested species in the Chesapeake Bay. As a result of concerns over potential recruitment overfishing, regulations to conserve mature females were adopted in 2008, which resulted in a four-fold increase in the female to male sex ratio. The potential effects of the new regulations on the operational sex ratio at mating have raised concerns regarding the potential for sperm limitation. Our objective was to understand the effects of present day regulations on future stock abundance. We created an individual-based, molt process model to simulate the effect of mating strategies and male harvest on the long-term sustainability of the blue crab population. We modeled growth as a function of temperature using an accumulated degree-day intermolt period and a size-dependent growth per molt. Maturation was also size-dependent with different maturity curves for each sex. Females mated only once during their terminal molt. Males could mate with multiple females, and the model monitored the amount of sperm each male transferred to a female as a function of time since last mating. After receiving sperm, a female began producing batches of eggs. The proportion of eggs fertilized in each brood was determined from the number of eggs in a brood and the quantity of sperm stored. The sperm used to fertilize the eggs was subtracted from the amount stored and total successfully fertilized eggs were monitored for each female crab. We applied a range of sex specific fishing pressures, including scenarios representing current and prior management, to determine their effect on fertilized egg production. Preliminary results indicate current regulations and observed sex ratios in Chesapeake Bay are not sufficiently skewed to cause sperm limitation concerns. This means current sex-specific regulations should not negatively affect future stock abundance based on the sex ratios they produce within tributaries.

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EVALUATING SPATIAL AND TEMPORAL PATTERNS IN *ZOSTERA MARINA* GROWTH OVER 28 YEARS IN CHESAPEAKE BAY, USA

Zostera marina serves as a key indicator of the health of Chesapeake Bay and its status is used in evaluating the effectiveness of Bay management. Understanding the relationship between regional water quality and Z. marina bed dynamics is hampered by substantial spatial variability among and within grassbeds, such that examining the entire vegetated area may mask important linkages exhibited by the most sensitive grass regions. This study, utilizing data from a 28-year annual aerial monitoring program, uses a grid-based approach to examine local dynamics within seagrass beds in the lower Chesapeake Bay, excluding regions where Ruppia maritima dominates. Seagrass polygons were coded on a grid with 25m2 cells and classified annually based on the change observed each year. Particular focus was given to two types of growth: increased density within existing seagrass and new growth in unvegetated cells. We document the spatial characteristics of these regions supporting annual growth and evaluate them in the context of their local neighborhood and long-term trends at each site. We found that the key factors in the establishment of new seagrass in unvegetated areas were the distance to existing seagrass beds, abundance of seagrass in the local neighborhood, and depth. Within the seagrass beds, growth (density increase) was related to distance from the bed edge and the number of years that the site had been

vegetated. By better understanding the spatial context influencing growth in Z. marina, we can focus more closely on the mechanisms influencing the relationship between regional water quality and Z. marina status and trends.

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NUTRIENT AND ALGAL BLOOM DYNAMICS IN SAN FRANCISCO ESTUARY: PHYTOPLANKTON NITROGEN UPTAKE AND PRIMARY PRODUCTION RESPONSE TO CHANGING ANTHROPOGENIC NITROGEN LOADING AND N:P RATIOS

For two decades, studies of phytoplankton in the San Francisco Estuary (SFE) focused on measuring standing stocks and species composition with relatively few direct measurements of primary production and virtually no estimates of nitrogen uptake. The paradigm was that elevated inorganic nutrients had no impact on algal blooms. Recent studies have challenged this view, suggesting that the chemical form of inorganic nitrogen (N) and nitrogen to phosphorus ratio in SFE waters may influence algal production and the occurrence of blooms as well as food web composition. With increasing human population, anthropogenic N loads to estuaries and coasts are increasingly in reduced forms (ammonium; NH4, urea) rather than oxidized forms (nitrate; NO3). Ammonium may inhibit the potential for phytoplankton blooms (oligotrophication) by preventing access to NO3. This may also shift phytoplankton functional groups away from diatoms to groups that are more NH4-tolerant. We evaluated whether N redox state and N:P stoichiometry would influence SFE phytoplankton by conducting experimental enrichments with combinations of NH4, NO3, urea and P. The inhibition of NO3 uptake was consistently observed with NH4 enrichment. Phytoplankton altered N : P assimilation in response to experimentally manipulated N : P availability. Finally, NH4 enrichment and higher initial N:P promoted the growth of cryptophytes while NO3 enrichment and lower initial N:P promoted diatom growth. These findings provide a revised, nuanced view of how changes in estuarine and coastal nutrient loading will influence eutrophication responses.

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ARTIFICIAL REEF BIOFILMS IN MISSISSIPPI SOUND: RESPIRATION RATES AND NUTRIENT DYNAMICS

Estuarine systems are often nutrient limited, but the presence of artificial reefs can improve nutrient cycling and enhance microbial growth. Colonized rubble recovered from two low relief and two high relief artificial reef sites in Mississippi Sound was used in laboratory incubations to examine nutrient dynamics and respiration rates over a 14 month period. Bacterial production was expected to be highest in incubation chambers containing biofilm compared to control chambers (water only), but this was not observed, as water column bacterial abundances often decreased over time in chambers containing biofilm, likely due to bacteria settling on the substrate or consumption by grazers. However, respiration rates were much greater in chambers with biofilm than controls, with low relief biofilms showing the highest respiration rates, indicating the greatest biological activity at low relief reefs. Incubation chambers containing biofilm also showed greater increases in phosphate and ammonium concentrations over time relative to control chambers, with low relief biofilms showing the greatest increases in these nutrient concentrations. These results indicate that biological activity within the biofilm enhances nutrient remineralization at artificial reef sites, and that low relief reefs are greater nutrient sources than high relief reefs. However, transect samples collected near each reef site showed low or undetectable nutrient concentrations in the water column likely due to dilution with surrounding water and/or biological uptake. Based on these results, it can be concluded that artificial reef biofilms act as nutrient sources to Mississippi Sound, and depending on water depth and tidal influence this nutrient flux may significantly impact coastal biogeochemical cycles.

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GEOMORPHOLOGICAL RESPONSES TO ANTHROPOGENIC ALTERATIONS WITHIN THE NAKDONG AND YEONGSAN ESTUARIES, SOUTH KOREA

On the Korean Peninsula, significant anthropogenic alterations have occurred to drainage basins and estuaries due to river diversion for agricultural practices, coastal construction of estuarine barrages, and extensive seawalls in land reclamation projects. Over the past century these practices have considerably modified the shoreline and altered both net transport of sediment and freshwater from these systems and modulated the timing and intensity of the discharge. As a result, the sediment dynamics and ecosystems within the estuaries have been significantly altered. Considering drainage basins >500 km^2, 56% of rivers reaching the coast in South Korea have been occluded by an estuarine dam, restricting delivery of sediment and altering/preventing natural tidal exchange of fresh and saltwater. The Nakdong and Yeongsan Estuaries are prime examples and are respectively representative of micro and macro-tidal estuaries found in the region. The impacts of the modifications include a substantial decrease in the tidal prism, reduction of accommodation space in intertidal zones, and changes in the dispersal mechanisms and accumulation of sediments. In order to assess these alterations, a series of gravity and vibracores were analyzed using ^{210}Pb and ^{137}Cs radioisotope geochronology, laser diffraction particle analyses, and X-radiography. Additionally, side scan sonar and CHIRP seismic data were collected. Our observations have found a shift in depositional environments as a natural response to an extensive array of anthropogenic alterations. The changes in sediment trapping efficiency that have ensued resulting from extensive coastal construction provides the basis for reevaluating traditional facies models for estuaries in the Anthropocene.

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LONG-PERIOD WAVE FORCING IN BAR-BUILT ESTUARIES – OBSERVATIONS OF SURF BEAT AND THE MARCH 2011 TSUNAMI IN A HIGHLY-STRATIFIED CALIFORNIA ESTUARY

Very small intermittently-open estuaries, such as those found in California, South Africa and Australia, are morphologically defined by their unstable mouths. These estuaries are protected behind a sandy beach and coupled with a constricted mouth are seen to remain highly stratified in the presence of both salt and freshwater inputs. An interesting feature of these estuaries is the presence of visible waves or tidal bores of a 30-second or longer period during some phases of the tide. These waves are attributed to infragravity waves, or surf beat, in the near-shore. Rather than observing constant flood tide velocities, these infragravity waves pulse water into the estuary resulting in oscillatory flow with typical velocites less than 0.4 m/s. However, after the tide falls below a threshold, ocean forcing is restricted and ebb velocities are relatively constant. Observations made during the March 2011 tsunami in the Pescadero estuary in Northern California show that the tsunami induced velocities exceeding 0.6 m/s for several days after the instigating earthquake. As the “tidal wave” rose, high velocities to pulsed in with infragravity frequencies which were cut off as the “tidal wave” fell, on a 20-40 minute tsunami wave period, rather than on a 12 hour tidal period. In small bar-built estuaries, the energy carried in by infragravity waves is an important contribution to an otherwise low-energy system, and even a small amplitude tsunami may overwhelm these shallow estuaries.

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MODELING CLIMATE CHANGE AND IMPLICATIONS FOR RESTORATION PRACTICES IN CHESAPEAKE BAY AND ITS WATERSHED

Mean annual temperature and precipitation in the Mid-Atlantic, USA, increased over the last century, and global climate models generally project further increases in this region throughout the year 2100. Although higher temperatures may increase evapotranspiration thereby decreasing total annual baseflow, possible increases in the magnitude and intensity of stormflow events will, in turn, increase nutrient and sediment fluxes to Chesapeake Bay. Moreover, development of the watershed will likely increase impervious surfaces, the ratio of stormflow to baseflow volumes, and further increase solute fluxes. Increasing nutrient and sediment loads to Chesapeake Bay in the late winter and spring combined with increases in water temperature, especially in the summer, could accelerate the decay of organic carbon and increase hypoxia and anoxia as well as decrease the extent of submerged aquatic vegetation. The possibility of increasing riverine flow associated with climate change this century necessitates an evaluation of stream network and tidal marshland performance to higher flows so that we can 1) develop a better understanding of their capacity to adapt to projected changes in nutrient and sediment loads and 2) evaluate what type of and where restoration practices should be implemented. The headwaters of the Patuxent watershed are located in one of the most developed areas of the Chesapeake Bay watershed. Moreover, runoff flows through an extensive tidal marshland before reaching the mid to lower estuary. Thus, the Patuxent watershed and estuary represent an ideal system to explore these questions. Scenarios from the Chesapeake Bay Program’s linked watershed and estuarine models were used to determine climate and land use change effects on river runoff

and estuarine water quality. Implications for watershed management and restoration are discussed.

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MANAGING MULTIPLE VECTORS FOR MARINE INVASIONS IN AN INCREASINGLY CONNECTED WORLD

Many non-native species have been introduced through a variety of vectors to estuaries, bays, and coasts around the world. Of these multiple vectors, which often operate currently, ballast water discharge has received the most attention by scientists and the management community, but a comparison of multiple vectors is lacking. We assessed the historical and potential contemporary contributions of eight maritime vectors to non-native species establishment in California's coastal waters. The majority of the 213 non-native species established as of 2011, most were attributed to two to six probable vectors. This result indicated that vector management must diversify from a focus primarily on commercial shipping, yet comparisons across vectors were difficult. Comparisons across vectors were possible only as order-of-magnitude differences in fluxes of species circulating in each vector, due to lack of standardized data on the numbers of species and their abundances. Despite the data gap for comparing fluxes across multiple vectors, clear opportunities for management exist. Ballast water certainly has been an important vector, but vessel biofouling looms large as a major vector and also a management opportunity. An important step is to identify a central authority for permitting and data collection infrastructure that covers multiple vectors. Non-native species associated with sales of bait, seafood, aquaculture, and ornamental species should be tracked and estimates made of escapes/ releases into the environment. Educational campaigns should target fishing and recreational vessel owners and aquarium hobbyists.

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MESOCOSM ASSESSMENT OF *SPARTINA ALTERNIFLORA* GROWTH RESPONSES TO WEATHERED MACONDO WELL OIL APPLIED TO ABOVEGROUND TISSUES AND SOIL

We utilized a mesocosm study to determine how the application of weathered Macondo well oil to either *Spartina alterniflora* aboveground tissues (50% and 100% coating) or associated soil (10 L m^{-2}), or both affects *Spartina alterniflora* survival, growth, and relevant biogeochemistry. We assessed both instantaneous (photosynthetic processes) and integrated (biomass partitioning) indicators of *Spartina alterniflora* growth responses and a range of biogeochemical characteristics. Analyses are ongoing, but findings thus far indicate that oiling of aboveground tissues or oil applied to the soil surface was significantly deleterious to *Spartina alterniflora* health. Complete coating of aboveground tissues with oil significantly reduced light-adapted chlorophyll fluorescence shortly after the inception of the study. By the conclusion of the study, net CO_2 assimilation, chlorophyll content index and light-adapted chlorophyll fluorescence were all significantly reduced by complete coating of aboveground tissues. Live aboveground biomass was also significantly lower in treatments experiencing complete coating of plant tissues than controls at harvest. Soil oiling significantly impacted *Spartina alterniflora* health, with the percentage of live stems significantly reduced midway through the study and virtually complete mortality of aboveground tissues occurring by harvest. Soil redox potential was poised significantly higher in the soil oiling treatment than in the control at harvest, although both treatments displayed moderate soil reduction. Interestingly, by the conclusion of the study total interstitial sulfides were significantly elevated in mesocosms experiencing soil oiling, suggesting that soil gas exchange may have been hampered by the application of oil. These findings indicate that the oiling of either aboveground plant tissues or soil impact *Spartina alterniflora* short- and long-term growth responses, as well as key aspects of salt marsh biogeochemistry.

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FIRST-YEAR, GRADUATE STUDENT COLLABORATIVE RESEARCH IN THE ST. THOMAS EAST END RESERVES: AN ENDURING PARTNERSHIP BETWEEN THE UNIVERSITY OF THE VIRGIN ISLANDS AND THE NATURE CONSERVANCY, ST. THOMAS, USVI

In the second semester of the University of the Virgin Islands' (UVI) Masters in Marine & Environmental Science Program, first-year students conduct a semester-long, class research project that applies elements from core courses taken in their first year to the real world. For the past five years, the program has worked with the Nature Conservancy (TNC) to complete projects within the St. Thomas East End Reserves(STEER), a network of protected areas on the east end of St. Thomas, USVI. Projects inform science and policy needs identified in STEER's Management Plan and have included assessments of mangrove, sea grass, and coral health, reef fish distribution and diversity, patterns of marine debris, and documentation of water quality. This year's research built on the results of the 2010 project and focused on evaluating changes in *Rhizophora mangle* prop-root invertebrate communities along a water-quality gradient extending from the inner to outer sections of Mangrove Lagoon. Students planned and executed all aspects of the study with guidance from UVI faculty and TNC staff. Project deliverables included: (1) poster and oral presentations of study results at UVI Research Day (a public event) and the STEER Core Planning Group (a managing board involving individuals from UVI, the USVI Department of Planning & Natural Resources, Environmental Protection Agency, TNC, and other local, non-profit groups), (2) preparation of study results for publication, and (3) creation of public outreach materials (educational signage and video). This partnership between UVI and TNC has resulted in strong student investment in these projects, likely because of (1) the application of class-room taught skills in the field to a real-world problem of local significance, (2) the chance to partner and network with individuals from federal, territorial, and non-profit sectors, and (3) the opportunity for open dialogue with project partners and the public through communication of study results.

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A COASTAL HIGHWAY: PLANKTON IN THE FAST LANE OF CHANGE

Karen Helen Wiltshire, Maarten Boersma, Sopha Mith-Kong, Elena Shchekinova, Alexandra Kraberg, Kristine Carstens and Silvia Peters. Biologische Anstalt Helgoland; Alfred-Wegener Institute for Polar and Marine Research. P.O. Box 180; 27484 Helgoland, Germany. In 1962 a long-term monitoring programme (Helgoland Roads) was started at the Biologische Anstalt Helgoland. This involved monitoring pelagic nutrients, salinity, light penetration and plankton species composition at the Kabel-Tonne (54° 11,3`N, 7° 54,0`E) on a work-daily basis. This time series is now one of the richest temporal marine data sets available with a pelagic data set comprising of phytoplankton, salinity, Secchi and nutrient values. Concurrently the time series are augmented by the biological parameters zooplankton, rocky shore macroalgae and macro-zoobenthos and bacteria data series which were sampled discontinuously until the 1990ties and which now have been restarted. Until recently it was relatively difficult to interpret the long term data acquired at Helgoland. This was mainly due to a lack of meta-information and quality control of the data which has now been rectified. These data sets are presented and examples of the major changes in evidence for phytoplankton are given and placed in an overall context with other monitored data ranging from zooplankton through to macro-benthos at Helgoland. Changes seen in currents, salinity, temperature and nutrients are used as a backdrop and related to changes in species.

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RANGIA CLAM DECLINE AND RESOURCE MANAGEMENT: HOW FRESHWATER INFLOWS INFLUENCE ECOLOGY IN GALVESTON BAY, TEXAS, USA

Freshwater resources are a major focus in modern environmental management strategies. Resource managers are challenged with determining the balance between human and ecological needs regarding the available sources of freshwater. To quantify the environment's demand for limited resources, managers observe the responses of organisms within the ecosystem to changes in resource delivery. Organisms which are sensitive to such changes are known as bioindicators. Literature suggests that the brackish-water clams Rangia cuneata and R. flexuosa (Rangia spp.) are good bioindicators of environments impacted by freshwater inflows due to their low salinity tolerance and limited mobility. Rangia spp. may also serve as indicators of shifts in phytoplankton populations impacted by changes in freshwater inflows as the clams are dependent on such organisms as their principal dietary source. Numbers of Rangia spp. have been declining in Galveston Bay, Texas (USA) according to historical sampling data (1982 to 2010) from the Texas Parks and Wildlife Department (TPWD). In previous analyses comparing TPWD clam distribution data with Texas Commission on Environmental Quality water quality data, individual stressors such as temperature and salinity did not appear to have strong relationships with Rangia spp. decline in Galveston Bay. The current study examines the influence of physical and chemical factors on biological parameters in Galveston Bay and their cumulative impact on Rangia spp. Observing changes in the rates of freshwater inflow in conjunction with changes in nutrient composition (amounts and ratios) and chlorophyll a levels in Galveston Bay since the 1980s helps to form a better understanding of the stressors affecting Rangia spp. Ultimately, learning more about the sensitivity of Rangia spp. to anthropogenically influenced environmental changes can provide insight on ecological requirements which help to inform management strategies regarding freshwater inflow.

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TIDAL MARSH VERTICAL ACCRETION PROCESSES IN THE SAN FRANCISCO BAY-DELTA: ARE OUR MODELS UNDERESTIMATING THE HISTORIC AND FUTURE IMPORTANCE OF PLANT-MEDIATED ORGANIC ACCUMULATION?

Vertical accretion of coastal peats is regulated over millennia by accommodation space generated by sea level rise (SLR). Processes constraining coastal peat accretion – primarily production and decay of above- and belowground biomass – are driven by environmental factors that fluctuate greatly with time and space across marsh locations and conditions. Historic records (0-6700 yr) and recently documented rates of organic accretion in the San Francisco Bay-Delta (SFB-D) are in conflict with results of marsh accretion models calibrated with mineral-rich horizons and short hydrologic records (<100 yrs). Sediment supply has been artificially enhanced in SFB-D since the mid-1850s due to a massive liberation of sediment from hydraulic gold mining. As this pulse of erodible sediment abates, the organic production and decomposition dynamics responsible for SFB-D marsh elevations under sediment-poor conditions are critical for both hind- and forecasting marsh accretion. Rather than expecting inevitable marsh drowning due to the decline of this sediment pulse, we suggest that organic accretion alone has been and may continue to be sufficient to maintain marsh elevations in several low-energy settings of SFB-D. We present new data on both 1) historic macro-organic matter distributions (fibric remnants <2mm), as an index of organic preservation and 2) current evidence of extremely high rates of belowground productivity of tule (Schoenoplectus acutus), a dominant bulrush in brackish-freshwater marshes. Given the complicated chemical and physical role of suspended sediment delivery and deposition, and the need to predict SLR responses among marsh types, we suggest three improvements for tidal accretion models: 1) calibration across a greater range of historic watershed conditions, 2) mechanistic algorithms that link mineral and organic inputs biogeochemically and physically, and 3) greater representation of plant responses and/or sensitivity to flooding and salinity conditions.

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ESTIMATES OF DECADAL TO CENTENNIAL SALINITY PATTERNS AND APPLICATION TO RESTORATION OF ESTUARINE ECOSYSTEMS: AN EXAMPLE FROM SOUTH FLORIDA

Restoration of the Greater Everglades Ecosystem is dependent on finding a compromise to diverse demands for freshwater for residential and agricultural needs, as well as for restoration of the ecosystem. Freshwater availability in the wetlands ultimately affects the downstream estuaries. This link between salinity in the estuaries and freshwater in the wetlands provides a means to estimate past hydrologic conditions, which gives managers information on the natural hydrologic functioning of the ecosystem. The key is to derive estimates of past salinity from paleoecologic analyses of radiometrically-dated sediment cores from the estuaries. Specifically, we analyzed molluscan faunal assemblages in the cores and compared them to a modern analog dataset. The cumulative weighted percent method (CWP) calculates an average salinity value for each core sample by multiplying the average salinity derived from field observations of living species by the percent abundance of each species in each sample, then dividing by 100. Near-shore or basin correction factors can be applied, depending on location of the core, to account for wide salinity tolerances of euryhaline species. The CWP method was tested using modern samples from locations near water monitoring stations that record salinity; the result was the CWP came within two psu of estimating observed salinity. The CWP method was applied to five sediment cores collected in Florida Bay. The results indicate that salinity for the five cores was on average seven psu less around 1900 CE compared to average observed salinities from approximately 1990-2009 CE; when the correction factor was added to nearshore sites, the difference is 15 psu. These paleosalinity estimates were used in linear regression models that relate salinity in Florida Bay to stage and flow in the wetlands. The results are estimates of historic hydrologic conditions that can be used to develop targets and performance measures for restoration.

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MODERNIZING HEIGHTS RELATIVE TO LOCAL WATER LEVEL AT ASSATEAGUE ISLAND NATIONAL SEASHORE

Assateague Island National Seashore (ASIS) is a barrier island where coastal environmental processes are determined by water level. Reference of natural, cultural, and facility resources relies on accurate elevations to determine vulnerability to a rising water level. Modern GNSS (GPS) technology gives resource managers the ability to quickly determine up to date elevations of those resources. Further, this technology, combined with conventional survey techniques, allows managers to update heights in regionally subsiding areas, has the potential to estimate a local subsidence rate, and can identify compromised survey control. Survey networks, or height modernizations, give land managers a better starting point for vertical reference. As a final step to make those elevations relevant to local needs accurate reference to local water level is critical. In many cases local tidal datums are available, but have some pitfalls in that they are referenced to a static National Tidal Datum Epoch while water levels continue to rise. The current tidal datum epoch of 1983-2001 is 12 years out of date and a source of error where sea level rise is a real concern. Land managers at ASIS are supplementing water level data by installing tidal monitoring stations. Calculated datums from those tide gauges will then be implemented within the survey control network. Having current tidal info and accurate relative reference to critical resources is giving ASIS land managers the tools they need to make informed decisions.

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BETWEEN THE BAY AND A HARD PLACE: THE EFFECTS OF BULKHEADING ON DIAMONDBACK TERRAPIN NESTING IN BARNEGAT BAY, NEW JERSEY

Barnegat Bay exhibits the highest development rate of any Mid-Atlantic estuary. In fact, bulkheading has increased 30% over the past thirty years along these shorelines, severely limiting the aquatic-terrestrial interface for wildlife. The diamondback terrapin (Malaclemys terrapin) requires the upland habitat that is blocked by bulkheading for annual nesting. To determine the effect of bulkheading on this threatened species' reproductive behavior we measured terrapin movements, stress levels, and site fidelity in relation to artificial bulkheading over two seasons. Nesting terrapins were displaced six times further from their initial point of emergence due to bulkheading. In addition, females were found to spend significantly more time in the aquatic habitat outside of the nesting beaches where bulkheading was present. Temporal and spatial displacement of nesting terrapins due to bulkheading has repercussions on individual fitness and can lead to overall population decline. With the increasing rate of development and subsequent bulkheading in Barnegat Bay, how can these data on animal behavior be utilized towards more ecologically-friendly erosion control and effective restoration practices? This study acts as a novel approach to guide restoration in America's estuaries. We propose that our animal behavior records can be applied towards effective shoreline restoration (i.e., living shorelines) in Barnegat Bay and any other systems where wildlife are threatened by hard shoreline stabilization such as bulkheading.

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AVIAN RESPONSE TO TIDAL SALT MARSH RESTORATION AT BANDON MARSH NATIONAL WILDLIFE REFUGE IN SOUTHERN OREGON

During the last 150 years over ninety percent of the estuary habitat in the Coquille River system on the Southern Oregon coast has been lost or altered due to anthropogenic activity.

A portion of this degraded habitat is included in Bandon Marsh National Wildlife Refuge (BMNWR). The 360 ha BMNWR is comprised of the Bandon Marsh and Ni-les'tun units and has been designated an Important Bird Area by the National Audubon Society. The Ni-les'tun unit was formerly a tidal marsh but was diked and drained for agricultural purposes in the early 20th century. The marsh was restored by the US Fish and Wildlife Service (USFWS) in 2011 with the primary goal of expanding habitat for migratory birds and fish, and became the largest tidal marsh restoration project in the state of Oregon. Ongoing bird surveys have been conducted on a weekly basis on both the restoration site and natural tidal marsh habitat during the breeding season, and on a bi-weekly basis during the non-breeding season beginning two years prior to the restoration in 2009. To partially justify the resources expended for this project, managers intend to determine if project goals for the avian community were met. This research seeks to analyze the existing survey data to describe the changes in species' density and community composition of the birds targeted by the restoration. Analyses will be conducted at both the foraging guild and the individual species levels. Community diversity indices will be used to describe changes in the avian community composition, and changes in population densities of resident species before and after restoration will be compared. Project results will inform expectations of restoration practitioners about the avian response to tidal marsh restoration projects.

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TOWARDS AN ECOSYSTEM MODEL FOR PREDICTING EFFECTS OF INVASIVE COLONIAL TUNICATE FOULING ON EELGRASS (*ZOSTERA MARINA*) GROWTH

Invasive colonial tunicates (golden star, *Botryllus schlosseri*; violet, *Botrylloides violaceus*) have been observed fouling eelgrass beds in Atlantic Canada. Heavy epiphyte fouling of eelgrass is unusual in this region, and thus tunicate fouling may have new and important ecological consequences. We are developing one of the first dynamic simulation models of eelgrass growth for Atlantic Canada, and will use this model to better understand the effects of invasive tunicates on eelgrass growth and production. The model is comprised of differential equations for carbon mass of aboveground and belowground plant components. Biomass is gained through photosynthesis, and lost through respiration, translocation, exudation, and natural mortality. Photosynthesis is a temperature-dependent function of maximum growth rate, limited by photosynthetically active radiation (PAR) and nutrients. PAR availability at the eelgrass canopy is modelled by incorporating annual and daily light cycles, and attenuation through the water column. Respiration is modelled as a temperature dependent exponential function, natural mortality as a density-dependent function of maximal biomass, and translocation and exudation as constant rates. Field data of water temperature, PAR, water depth, nutrients, attenuation coefficients, and leaf length was used to calibrate the baseline model. The model was validated using field data of above- and belowground biomass and shoot productivity collected monthly over a one year period. The validated baseline model will be used for simulation analyses to predict consequences of tunicate fouling. Field derived relationships of tunicate biomass and PAR attenuation will be used, and tunicate induced shoot mortality will be included as a loss term. Effects of water temperature on tunicate settlement and growth, and the resultant impacts on eelgrass, will be explored.

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SEASONAL CHANGES OF SEDIMENTARY ENVIRONMENT AT THE MACROTIDAL FLAT IN GOMSO BAY, WEST COAST OF KOREA

The sedimentary processes in the tidal flats on the west coast of Korea are directly influenced by monsoons, resulting seasonal deposition and/or erosion of sediments. Gomso bay on the mid-west of Korea is composed of a main channel to the north and the wide tidal flat with abundant tidal creeks to the south. The sedimentary analyses were investigated to understand seasonal sedimentary processes of tidal flats in Gomso bay. The surface sediments in the tidal flat were classified into three sedimentary facies. Generally, sandy sediments were dominated in the outer tidal flat of the bay in spring 2011, but the area of silty sand sediments extended from middle to the outer tidal flat of the bay in summer 2012. The short-term sedimentation rates were obtained from three lines by burying a plate at sub-bottom depth from May 2011 to May 2012. In the tidal flat at inner bay (KB- Line), the annual sedimentation rates were ranged -8.91 to 41.58 mm/year with the net deposition rate of 16.04 mm/year. The deposition on KB-Line occurred in autumn, winter and spring. The erosion was dominated on the tidal flats at middle (KH-Line) and outer bay (KM-Line) during autumn and winter with an annual erosion rate of -1.71 mm/year and -11.98 mm/year, respectively. The 12.5 hours anchoring survey at the bay mouth was revealed a large amount of suspended sediments were transported into the bay during a tidal cycle in spring 2012. Based on REE geochemistry, the tidal flat could receive resuspended sediments by tidal erosion at southern muddy coastal area during spring and summer. Additionally, Jujin Stream also supplied silt-dominated sediments at middle bay around KH-Line after summer rainfall. The seasonal variations of sedimentation on tidal flats showed that the deposition occurred with an inflow of muddy sediments by tidal current and rainfall in spring and summer, whereas the erosion was dominated by wave in autumn and winter.

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FROM THE CATCHMENT TO THE ESTUARY - LINKING NUTRIENT LOADING TO ESTUARINE FOOD WEB STRUCTURE

Nutrient availability is a critical variable controlling primary production and the structure and dynamics of higher trophic levels in estuaries. We investigated the links between nutrient loading, benthic primary producer communities and food web structure in eight estuaries scattered across the state of Victoria (Australia). Effective annual total (TN) and total inorganic nitrogen (TIN) loads to the estuaries were estimated from time-series of nutrient concentrations, river flow, and an estimate of water residence time in the estuary. Aerial photography and in situ groundtruthing were used to map the spatial coverage of seagrass, macroalgae and bare sediment habitats in each estuary. Community and food web structure (including autotrophs, invertebrates and fish) were assessed by means of a seine survey that targeted the three habitats identified above; specimens were collected for ^{13}C and ^{15}N stable isotope analysis. Estimates of effective N-loads showed a gradient of loading conditions that ranged from high effective N-loads in estuaries with highly modified catchments, to low effective N-loads in estuaries with relatively pristine catchments. Seagrass coverage peaked in those estuaries experiencing intermediate effective N-loads; whereas, the ratio of seagrass coverage to total vegetated area was inversely related to effective N-loading. Community composition and stable isotope data from the seine survey revealed spatial and temporal differences in food web structure among habitat types and across estuaries. Importantly, seasonal patterns suggest that the influence of nutrient loading on estuarine food web structure is dynamic and varies intra-annually. Overall, our data indicate that bottom-up forcing by catchment-derived nutrient loads is an important factor influencing the structure and dynamics of food webs in these estuaries.

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PHYSICAL CONTRIBUTORS TO HYPOXIA IN COASTAL UPWELLING SYSTEMS : A CROSS-SCALE OVERVIEW

Hypoxia in coastal upwelling systems is the integrated result of many processes spanning largest scales of ocean basin circulation to the smallest scales of turbulent mixing. Using the California Current as an example, I will review the major contribututs to dissolved oxygen variability and the potential development of extreme hypoxic events in Monterey Bay and the Southern California Bight.

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USING ACADEMIC COMMUNITY ENGAGEMENT (ACE) TO CONNECT ACADEMIC OBJECTIVES AND COMMUNITY PARTICIPATION

Issues in the field of coastal and estuarine science are constantly changing and the forward thinkers in the field must have the ability to critically assess new issues and problems from multiple perspectives. Through employing an Academic Community Engagement (ACE) teaching method, educators can move students beyond simply qualifying the interrelationships between human activities and the environment to provide students with a true interdisciplinary approach to assessing and understanding scientific topics. Using the ACE method, students are immersed in a semester-long community outreach project where they work to understand the theoretical science behind real world environmental science issues. Through working hand-in-hand with community outreach partners, students learn to consider the economic, political, civic and social factors that influence environmental change and shape our response to it. In ACE courses, community outreach projects work to synthesize the scientific concepts presented in class, with student groups presenting a final report to both their peers and community partners highlighting their findings and recommendations. The ACE experience, it is hoped, will help students be viewed both by their peers and the community as a positive force working to deepen their understanding of their role as a citizen in the community and a steward of our environment.

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ASSESSMENT OF PRIMARY PRODUCTIVITY IN THE WINDSOR SALT MARSH

Salt marshes are an important aquatic ecosystem and play a major role in providing habitat, as well as protecting shorelines from storms and wave energy, supporting commercial fisheries and can improve water quality. The purpose of this undergraduate research project was to evaluate several factors that may influence the growth of *Spartina alterniflora* - on four marshes in the Southern Bight of the Minas Basin, Bay of Fundy. This project quantifies both the growth characteristics, such as height and biomass, and the spatial characteristics, of *S. alterniflora* on four salt marshes; Windsor, Elderkin, Starrs Point, and Ransom Creek. Data were collected at the four sites on October 10th and 11th, 2012. Vegetation height, biomass, elevation within the tidal frame, distance from nearest creek, and distance from the outflow of wastewater (at Windsor marsh) were determined for each sample plot, in the low, mid and high marsh zones. The results indicate that there is not one single factor that controls the growth of *S. alterniflora*, but that many of these characteristics act synergistically. It is also likely that wastewater outflow onto Windsor salt marsh is significantly contributing nitrogen to the system, influencing vegetation growth, and that moving this outflow will have an impact on the marsh.

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TEXTURE AND CHARACTERISTICS OF WETLAND SEDIMENT ALONG THE TEXAS-LOUISIANA COAST

Sediment in coastal wetlands plays a key role in stabilizing the vegetation, reducing the effect of storm surge, filtering the pollutants, and controlling biogeochemical cycles. Accumulation and transport of sediment on wetlands are controlled by various physical, geological and biogeochemical processes, such as river deltaic lobe switching, longshore sediment transport, coastal inundation during storm surge, binding of sediment by organic matter, as well as wetting and drying during extreme climatic events. In this study sediment samples were collected at multiple marsh areas along the Texas-Louisiana coast, and parts of sediment samples were dried in a laboratory oven at 40 degree C for over 24 hours to mimic the drying process during droughts along the Texas-Louisiana coast. Laser diffraction gain size analyses were performed on both wet (i.e., the raw samples collected from field) and oven-dried sediments. Results indicate that most sediment samples are either muddy or sandy, with relatively poor sortings and highly-variable median grain sizes. Sediment collected from more energetic hydrodynamics environment seems to be coarser than that from low-energy environment. Sediment became coarser after the oven drying, indicating strong binding of fine grained sediment by organic matter through forces like multiple hydrogen bonding or hydrophobic effects. Future work should be focused on the linkage of hydrodynamics, sediment dynamics and biogeochemical processes in coastal wetlands.

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CHESAPEAKE BAY PROGRAM WATERSHED MODEL SIMULATIONS USING NLDAS-II PRECIPITATION & METEOROLOGICAL DATASETS

The Chesapeake Bay Total Maximum Daily Load (TMDL) program drives water quality policy and management to achieve water quality standards in the Bay through reductions in nitrogen, phosphorus and sediment pollution. Comprised of a suite of tools developed around the Hydrologic Simulation Program Fortran (HSPF), the Phase 5.3.2 Watershed Model (WM) is used as an accounting tool in the development of the TMDL, as it tracks progress and guides future implementations of best management practices. Previous studies have established that the P5.3.2 WM performs well in simulating flow, nutrients and sediment. The comprehensive precipitation and meteorological dataset, developed by fitting multiple regression equations that relate observed data to latitude, longitude and elevation (XYZ), was used to force the WM. Availability of comprehensive high-resolution data products based on NEXRAD or climate reanalysis offer improved precipitation and meteorological assimilation datasets. We tested the NLDAS-II climate dataset by replacing climate forcing parameter in the existing calibrated WM. Simulation results show that sediment loads delivered to the Bay were reduced by 70% while nitrogen and phosphorus loads decreased by 5% and 15% respectively. Expectedly, calibration of the P532 WM using NLDAS-II climate inputs restored the model accuracy and improved the efficiency at some segments. NLDAS-II offers streamlined access to long-term dataset that offers potential to dynamically expand the simulation period and take advantage of recent observations. The extreme sensitivity of the calibrated parameters to the precipitation data generated using two different models has significant implications for management studies involving climate change. Particularly, this study suggests that the direct use of projected precipitation from different climate models (in absence of calibration) could involve significant errors in simulated estimates originating from model parameters.

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SALT MARSH-MANGROVE ECOTONES IN THE NORTHERN GULF OF MEXICO: A COMPARISON OF PLANT-SOIL VARIABILITY ACROSS STRUCTURAL GRADIENTS

In parts of the northern Gulf of Mexico coast, winter climate change is expected to result in mangrove range expansion at the expense of salt marshes, which may affect some ecosystem functions and services. To determine how mangrove forest migration and ecosystem development affect soil properties and processes, we compared plant-soil variability across structural gradients within three mangrove-salt marsh ecotones (one in each of three U.S. states: Texas, Louisiana, Florida). At each ecotone, we sampled 3 salt marsh sites and 9 mangrove sites that spanned a mangrove forest structural gradient using tree height as a selection criteria (36 total sites). We quantified plant community composition and structure, soil properties, and porewater characteristics at multiple strata or depth increments. Our initial findings show major differences between the three ecotones, which are likely due to regional abiotic variation (e.g., climate, parent materials, and landscape position). The Florida ecotone has higher soil organic matter and more developed forests. Some mangrove individuals in the Florida ecotone were greater than 8 m in height. The tallest trees in the Louisiana ecotone, a dynamic sediment-dominated deltaic system, were slightly greater than 4 m in height. Annual precipitation is much lower in the Texas ecotone, which we expect has resulted in higher soil porewater salinities, lower soil-organic matter development, succulent-dominated salt marshes, and shorter mangrove trees (< 4 m). In Texas, we found a significant relationship between mangrove forest structural attributes (e.g., cover, height) and soil property development (e.g., organic matter formation). Collectively, our results begin to characterize plant-soil linkages and regional ecotonal differences which is important information for coastal wetland resource managers and scientists seeking to better understand the ecological effects of mangrove forest expansion into salt marsh.

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CLIMATE CHANGE AND HURRICANES IN THE GULF OF MEXICO: ECOLOGICAL AND SOCIO ECONOMIC IMPLICATIONS

Coastal zone in the Gulf is highly vulnerable to severe floods, deltaic subsidence, wetland loss, beach erosion, sea-level rise, and heavily impacted by the appearance of hurricanes. From our observations –after hurricanes Katrina 2005, and Karl 2010-, a "thermal channel-funnel effect" was identified starting with a temperature of 27 oC in the North Atlantic Ocean and reaching into the Gulf of Mexico with temperatures higher than 33 oC. This "thermal channel" has been quite evident during the hurricanes season in years 2004, 2005, 2007, 2009 and 2010. The intensity of hurricanes has increased by 80% during the last 25 years. The frequency of hurricanes category 3 to 5, and the number of tropical storms is also 80% higher during the last 25 years. From 1995 to 2007, the 50% of category 3 to 5 hurricanes tracks have been crossing throughout the Mexican Yucatan Peninsula directly from the Caribbean Sea to the Gulf of Mexico. The economic impact in this region for the first decade en 21st century has been over $250 billion in damages. Because of its vulnerability the Gulf of Mexico is at severe risk in this 21st century, and this is the challenges for new strategies in coastal management. Key words: Frequency/intensity of hurricanes, Wider Caribbean, global changes.

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INTEGRATED SYSTEM OF ENVIRONMENTAL MONITORING AND ASSESSMENT IN ESTUARIES: A CASE OF PEARL RIVER ESTUARY IN CHINA

Estuary is a unique zone with complex hydrodynamic conditions and ecological habitat due to both river influx and tidal input. At the same time, estuaries tend to be the areas of highly urbanization and population intensity, suffering from increasing human activities and huge pressures. Therefore, environmental monitoring and assessments in estuaries are the

most important issues in management. In this paper, the integrated system of environmental monitoring and assessment in estuaries is initially set up. The concept of integrated system and the top-level design for environmental monitoring and assessment in estuaries are proposed based on the review of international practice and management objectives. The classification of environmental monitoring and assessment was identified following EU Water Framework Directives (WFD). The water surveillance monitoring scheme in Pearl River Estuary was redesigned and implemented using Step-by-Step approach according to monitoring classification, purposes and estuarine biogeochemistry principle, which included the improvements of monitoring scope, stations, frequency, sampling time and method using quasi-synchronous sampling method in low tide, monitoring elements and so on. The framework of operational monitoring and investigative monitoring are also proposed. The improvements of Chinese National Seawater Quality Standard are proposed including adding total nitrogen and total phosphorus indicators and their values in estuarine/transitional zones, and the concept of guarantee rate. Three comprehensive assessment methods, Environmental Quality Grading Assessment Method from NOAA, Decision Tree Method from EU WFD and improved Multi-Dimensional Decision-Making Approach, were used to conduct comprehensive environmental quality assessment, and finally set up the comprehensive assessment system of estuarine environmental quality.

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LINKING COMMUNITY VALUES TO SCIENTIFIC ASSESSMENT OF DECISION OPTIONS WITH STRUCTURED DECISION MAKING

Community-level decisions can have large impacts on production and delivery of ecosystem services, which ultimately affects community well-being. But engaging stakeholders in a process to explore these impacts is a significant challenge. The principles of Structured Decision Making (SDM) can be used as an engagement approach to identify the fundamental objectives of communities and can simultaneously inform decision alternatives, means to achieve them and performance endpoints. Fundamental objectives are stakeholder goals that can be used to structure and weigh measures of community wellbeing. Characterizing the means (intermediary actions) to achieve the fundamental objectives can be used to identify decision options. Relationships between means and fundamental objectives, which can be represented in a diagram called a means-ends network, form the conceptual basis for parameterizing quantitative models to predict the effects of alternative decisions on community well-being. We reviewed strategic planning documents from coastal communities to characterize their fundamental objectives and potential means to achieve them, such as enhancing economic viability by promoting eco-tourism. Objectives derived from documents were compared to those identified by stakeholders through facilitated workshop discussions, and used to generate a suite of measures of community sustainability that reflect stakeholder values. This information will be used to develop scientific information and models to predict the outcomes of alternative decisions on the long-term well-being of communities. I Integration of stakeholder values and scientific knowledge allows for a higher level of stakeholder understanding and acceptance of potential trade-offs arising from decisions, providing a higher potential for success in guiding community decisions towards sustainable outcomes.

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PHYTOPLANKTON IN THE PEARL RIVER ESTUARINE COASTAL WATERS: ANTHROPOGENIC AND CLIMATE INFLUENCES

The Pearl River is the second largest river in China, discharging into the Pearl River estuary. Hong Kong waters are located at the western edge of the estuary and they are largely influenced by the estuarine discharge, especially in summer. We used a relatively long term data set of phytoplankton species abundance and composition along with water quality data. The data from three zones are used, which represent an estuarine condition in the west (estuarine zone) and a coastal/oceanic condition (oceanic zone) in the east and a seasonal transitional condition influenced by the estuary in summer and by coastal/oceanic water in winter (transitional zone). The results show that total species richness including diatoms and dinoflagellates appeared to increase. Diatoms are the dominant group of phytoplankton. However, dinoflagellate species richness and abundance increased too. This may coincide with the increased frequency of Si limitation. A very interesting observation is that temporal increases in diatom abundance appear to be negatively correlated with the abundance of dinoflagellates and other species of phytoplankton. The above observations appeared to be more apparent before 1998, and the changes were more stable between 1999 and 2004. This two phase trend of changes coincides with climatic changes around 1996-1998 that are coherent with a regime shift in the PDO and large-scale changes in ocean temperature, regional wind patterns, and biological communities across the Pacific basin.

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RESOURCE COMPETITION UNDER CONTINUOUS AND PULSE INPUTS

Three lines of approaches have been adopted to account for the diversity of phytoplankton: equilibrium hypothesis, non-equilibrium hypothesis, and chaos hypothesis. Although each of the approaches contributed to understanding how phytoplankton species co-exist, we do not fully understand how phytoplankton diversity is maintained. Here I revisit the question using a variable storage model under continuous and pulse inputs of nutrients. I also used actual physiological parameters of many species from recent literature. Continuous input provides competitive advantages to affinity strategists, and leads to competitive exclusion. Pulse input provides advantages to velocity strategists making more species co-exist. Co-existence of many species on a practical time scale was possible under non-equilibrium condition even on single limiting resource. Continuous input modulates the effects of nutrient pulses on competition. As continuous input becomes relatively more important, fewer species co-existed and vice versa. I will discuss the implication of this result in terms of environmental characteristics.

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THE CHARACTERISTICS OF ALONG-CHANNEL SALINITY DISTRIBUTION IN A MACROTIDAL ESTUARY, GYEONGGI BAY, SOUTH KOREA: FIELD MEASUREMENTS AND NUMERICAL MODEL RESULTS

Gyeonggi bay (GGB) is located at the west coast of South Korea, and it is well known for its macro tidal characteristics; tidal range reaches more than 8 m. This estuary can be had distinctive feature of sea-water circulation system because estuarine system consists of 3 main channels and 3 rivers, through which major tidal flow and river discharge meet each other. To study distribution of longitudinal salinity in main channel of GGB, field measurements is conducted at 10 CTD points along the estuary during one tidal cycle of spring and neap periods, respectively. To determine variation of salinity and salt intrusion length by change of external forcing, a numerical model is established and verified with observation data. Based on observation data, the main channel is showed well- and partially mixed estuary during spring and neap tide periods, respectively. The vertical stratification during neap period is stronger than spring due to decreasing turbulent mixing. At flood tide, strength of vertical stratification is stronger than ebb because salty water intruded into the upward estuary near the bottom layer. However, a difference of horizontal salinity is showed discrepancy at spring and neap periods. The longitudinal salinity gradient of surface layer is stronger than bottom layer during neap. The along channel salinity gradient during spring period is presented similar difference value whole water column. The numerical results showed that the salinity distribution and salt intrusion length of this estuary can be temporal and spatial characterized by tidal forcing and river discharge.

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ELUCIDATING THE VALUE OF ECOSYSTEM SERVICES IN THE GULF OF MEXICO FOR THE PURPOSES OF CONSERVATION AND RESILIENCE: PART 1 – FOUNDATIONS OF ECOSYSTEM SERVICE RESILIENCE

Much has been written about ecological and socio-ecological resilience but there is very little theoretical or practical foundation for resilience of ecosystem services. We present, in part, the results of the recently released National Research Council report on impact of the Deepwater Horizon blowout on ecosystem services and specifically the impact on the resilience of services. We also expand upon that work to present a novel approach for considering the resilience of services in marine and coastal environments. Dramatic shifts in ecosystem structure and function can have a substantial impact on human well-being but there is still a disconnect between resilient ecosystems and resilient ecosystem services. They cannot necessarily be considered the same given that small shifts in ecosystem structure can lead to significant changes in the quality of services supplied. Coastal and marine protection and restoration decisions might focus on the habitat, the services, or both. But in order to make more effective decisions consideration of the resiliency of the system as a whole must be considered.

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DETERMINATION OF PHYTOPLANKTON GROUPS USING TURNER DESIGNS' PHYTOFIND

Turner Designs' PhytoFind is configured with multiple sensors, each with different excitation/emission wavelengths designed to distinguish among phytoplankton groups using group specific fluorescence characteristics. Preliminary lab data show positive results for differentiating among phytoplankton groups, which is desirable for monitoring efforts of most all aquatic habitats because it provides researchers with valuable data that can be

used for: predicting algal blooms, determining whether phytoplankton communities have the potential to be harmful, monitoring algal stock used for feeding aquaculture farms, detailed estimates of productivity and system turnover rates. The problems with this type of measurement are interference factors, primarily turbidity and dissolved organic material, that con-volute the fluorescence response from various algal groups making it difficult to accurately determine percent group contribution in a mixed phytoplankton community. Empirically derived correction factors used for correcting such interference are disadvantageous because they don't encompass the various types of materials that exist, both as dissolved organics and suspended sediments. The PhytoFind uses additional sensors configured to measure scattering and dissolved organic materials, along with algal fluorescence, simultaneously. This results in the generation of a correction factor per data point, increasing accuracy of measurement greatly. The PhytoFind's ability to accurately determine percent algal group contribution and provide phytoplankton concentration estimates makes it a powerful research tool for monitoring or characterizing algae in any type of system.

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A SNAIL'S PACE: DENSITY, MOVEMENT, AND FOOD CHOICE OF THE MARSH PERIWINKLE

Marsh periwinkles (*Littorina irrorata*) are one of the most abundant salt marsh animals, in addition to being an important food source for blue crabs and migrant birds. The purpose of this study is to determine snail movement from a fixed location, compare densities, and examine the snail's preferred food plant. Distance traveled in one month's time and densities were measured in the two salt marshes along the southeastern US coast. In the lab, salt marsh microcosms were used to determine which salt marsh plant was favored if given a choice between *Salicornia spp* or *Spartina alterniflora*. Our data suggests the snails move much farther contrary to the published literature. Overall densities of snails on Hunting Island (SC) and Cockspur Island (GA) were below suggested ranges published suggesting snail populations are under either top-down or bottom-up control. In the field, it appears the density of the snails seems to be determined by density of the *Spartina* and *Spartina* is a preferred food choice compared to the *Salicornia* in lab microcosms. Understanding the snail's movements in the field and their densities in relation to *Spartina alterniflora* health as well as their preferred food plant can help understand population dynamics in relation to salt marsh management.

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HAS THE EXPONENTIAL EXPANSION OF THE INVASIVE DWARF EELGRASS *ZOSTERA JAPONICA* IN YAQUINA ESTUARY, OREGON IMPACTED THE DISTRIBUTION OF THE NATIVE EELGRASS *ZOSTERA MARINA*?

The eelgrass Zostera marina occupies significant portions of marine-dominated intertidal and near-subtidal sectors of Pacific Northwest (PNW) coastal estuaries in the USA. In recent decades a non-native congener, Z. japonica, has become established in many PNW estuaries including Yaquina estuary on the central Oregon coast. We measured the horizontal and vertical distributions of the intertidal native and non-native eelgrasses between 1997 and 2013 in Yaquina estuary using ground mapping and color-infrared aerial photography with digital classification to assess the impact, if any, of Z. japonica on Z. marina's distribution. A bathymetric model was used to characterize the distribution of Z. marina and Z. japonica with intertidal elevation; peak abundances occurred at about 0.0 m and 1.5 m, respectively (MLLW). Moreover, the two species seldom occupied the same bathymetric zone of a tidal flat. The expansion pattern of Z. japonica was very different on the two major tidal flats in the estuary, and one of the densest meadows occurs near the outfall of the Oregon Coast Aquarium. Although the areal extent of Z. japonica increased exponentially over the study interval on both tidal flats, there was no significant change in the areal extent of Z. marina during this period.

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THE HUDSON RIVER FOUNDATION'S TIBOR T. POLGAR FELLOWSHIP PROGRAM: THREE DECADES ON THE HUDSON RIVER ESTUARY

The Tibor T. Polgar Fellowship program is a student research program administered and underwritten by the Hudson River Foundation for Science and Environmental Research, in cooperation with the New York State Department of Environmental Conservation, and the Hudson River National Estuarine Research Reserve. The program was initiated in 1984 and named in honor of the late Dr. Tibor T. Polgar, a major contributor to the early development of the Foundation. Each year, the program provides summer stipends and research funds for up to eight undergraduate or graduate students to conduct research within the Hudson River Estuary. Fellowships are awarded competitively, and student research proposals are reviewed by a panel of Hudson River scientists and resource managers. Originally limited to research projects conducted within the four components of the Hudson River National Estuarine Research Reserve (Stockport Flats, Tivoli Bays, Iona Island Marsh, and Piermont Marsh), the program was expanded in scope in 1988 to include consideration of research projects throughout the entire Hudson River Estuary and its tributaries, including Jamaica and Raritan Bays. The two primary objectives of the program are to 1) gather important information on all aspects of Hudson River ecology and 2) to train students in conducting scientific and public policy research. Additionally, students and their faculty advisors are provided unique, collaborative opportunities for mentoring and interaction with other Fellows and research partners. Over the past 29 years, the Polgar Fellowship program has supported over 230 students and produced a large body of Hudson River research, including numerous peer-reviewed journal articles. The Polgar Fellowship Program final reports are published annually by the Hudson River Foundation and made available to university and research institution libraries.

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THE EFFECT OF NON-NATIVE SPECIES ON TWO LIFE-STAGES OF EASTERN OYSTER *CRASSOSTREA VIRGINICA*

Since the introduction of Perna viridis (Asian green mussel), Mytella charruana (charru mussel) and Megabalanus coccopoma (acorn pink titan barnacle) into Florida waters, they have expanded both north and south along the Atlantic coast from their initial sites of introduction. Little is known about how these non-native species affect the ecological and economically important Crassostrea virginica (native Eastern oyster). Two manipulative experiments were designed to test if P. viridis, M. charruana and M. coccopoma affected two life-stages of C. virginica. First, we looked at the effect of non-native species on the settlement of C. virginica larvae. This experiment was completed using a recirculating, raceway flume. Our results indicate that, overall, the number of settled larvae was significantly lower in the presence of P. viridis, M. charruana and M. coccopoma when compared to the number of settled larvae in the presence of the native mussel Geukensia demissa (random block ANOVA, $p = 0.0364$). The second experiment examined the effect of non-native species on the growth and survival of C. virginica juveniles. This manipulative experiment was conducted in the field. The data showed that P. viridis and M. charruana negatively affect the growth and survival of juvenile C. virginica. Overall, this study suggests that non-native species can be detrimental to native oysters.

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VARIATION IN OYSTER PERFORMANCE BETWEEN AND WITHIN TWO RESTORATION SITES IN SAN FRANCISCO BAY

As part of a larger "living shoreline" project, we compared the performance of native oysters across five substrate types at two restoration sites in San Francisco Bay. Four substrate types constructed from "baycrete" (cement and locally dredged shell)— modular interlocking oyster blocks, stacks of small oyster domes (Oyster Reef Balls), large oyster domes (Bay Reef Balls), and large segmented oyster domes (Layer Cakes) — and stacks of Pacific oyster shell in mesh bags were deployed at the sites at the beginning of the recruitment season in summer 2012. Data collected in November 2012 and April 2013 show large variation in oyster recruitment between the two sites. Within each site, there is little difference in oyster density across the substrate types, but oyster numbers are consistently highest on north and vertical faces, and at lower tidal elevations, suggesting that thermal stress is a factor in oyster recruitment and/or survival at these sites. In addition to oysters, we enumerated other species that have also recruited to the deployed substrates, including small fish, algae, and sessile and mobile invertebrates. We also tested for interactions between oysters and native eelgrass, which was planted as part of this restoration project, and we compared oyster growth and longer-term survival across the substrate types and between locations, examined effects of the restoration project on the natural oyster populations at each site, and looked for community-level effects such as fish use of the restored sites. In addition, a team of hydrologists measured the ability of the oyster substrates and eelgrass to reduce wave intensity. This project adds to our understanding of restoration methods in terms of habitat creation and shoreline protection in the face of rising seas and increasing storm surges.

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DEVELOPMENT OF TURBULENCE DOWNSTREAM OF SHALLOW SUBMERGED VEGETATION

Aquatic vegetation relies on hydrodynamics to transport propagules and nutrients throughout the coastal environment. These propagules are advected and scattered throughout the coastline by mean flow and by turbulence to facilitate canopy expansion and patch recruitment. However, the processes that govern the development of the mean flow, the turbulent kinetic energy, and the Reynolds stress downstream of the canopy are poorly understood. Furthermore, although research in terrestrial canopies has shown that infrequent turbulent events may play a large role in canopy expansion far downstream, previous work in aquatic canopies has been limited to the near wake region. The work in this study thus focuses on the development of the turbulence at distances of up to thirty canopy heights downstream. In order to characterize the mean flow and turbulence development, we used acoustic velocimeters and particle image velocimetry to measure velocity at several locations downstream of a model canopy in a flume. We found that the flow evolves in distinct phases with changes in the mean flow occurring early, and turbulence statistics responding further downstream. Mechanistically this is because the turbulence experiences rapid-straining in the early phases, and dissipation dominates further downstream. This lingering turbulence signature may lead to enhanced mixing and transport of propagules much further than would be predicted by the mean flow alone.

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THE USE OF RNA:DNA RATIOS AS AN INDICATOR OF NUTRITIONAL CONDITION IN JUVENILE BLUE CRABS, *CALLINECTES SAPIDUS*

The success of post settlement juveniles of marine species is often linked to the condition and growth of individuals, with better conditioned, faster growing juveniles commonly experiencing higher survival. Understanding variation in recruitment of juvenile blue crab (Callinectes sapidus) in the Chesapeake Bay is important for improving knowledge of population dynamics and structure. The discrete growth pattern of crustaceans presents a challenge for the use of many traditional approaches to quantifying condition and growth. The development of nucleic acid ratios (R:D) as a physiological indicator offers a potential advantage for assessing the condition, and ultimately in situ growth, of crustaceans. To evaluate the potential of R:D ratios as indicators for juvenile blue crab condition, we conducted a conditioning experiment to investigate diet and temperature interaction on the condition and growth of 30-50mm juveniles. Nucleic acid ratios were estimated in several different muscle tissues including tissue within the abdominal cavity, walking legs and the cheliped merus using fluorometric quantification techniques. Preliminary results suggest juvenile blue crab R:D ratios respond positively to increases in food availability. Interestingly, R:D ratios did not appear to respond to temperature treatments as expected. By identifying the molt stage of an individual we can then reassess the influence of the molt cycle on blue crab nucleic acid indices. Our results emphasize the intricacy of the abiotic and biotic factors which influence growth and condition of juvenile blue crabs.

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LINKING NITROGEN AND CARBON CYCLING IN THE COASTAL OCEAN: IMPLICATIONS FOR CO_2 EMISSIONS, OCEAN ACIDIFICATION, AND LAND USE

The propensity of a coastal water body to emit or consume CO_2 is related to its “net ecosystem metabolism” (NEM). NEM is positive, or “autotrophic”, where gross primary production exceeds community respiration, and dissolved inorganic carbon (DIC) is consumed, and negative or “heterotrophic” where respiration exceeds production and DIC is generated. In turn, DIC generation is strongly related to CO_2 efflux at the sea-air boundary (measurable as partial pressure of CO_2 or pCO_2). Coastal NEM is controlled by the supply of organic matter to the system, either as direct loading of fixed material or from excessive inorganic nitrogen loading which fuels fixation and respiration in subsurface water. A potentially serious consequence of the evolution of DIC is lowered pH (acidification). Thus, there are important links between carbon and nitrogen cycles in coastal systems and inputs from land, which affect NEM, pCO_2, and acidification. In this talk we describe NIWA coastal nutrient budgets for the Hauraki Gulf and adjacent Firth of Thames (New Zealand), the latter of which receives high runoff from local region farming and is highly net-heterotrophic. We describe our recent ship surveys of the carbonate system of the Hauraki Gulf/Firth region which show high pCO_2 and significant acidification in the Firth. We show regional (Firth-Gulf-continental shelf) and seasonal variation in these properties, and how we are combining nutrient budget and carbonate system surveys with sampling of bio-optical properties to understand the drivers of NEM and to assess them using remote sensing.

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IMPROVED PARAMETERIZATION OF SEAGRASS BLADE DYNAMICS IN WAVY FLOWS

Understanding ecological processes in coastal waters requires characterization and quantification of the influence that seagrass meadows have on local hydrodynamics. These effects are incorporated into large scale coastal models by developing methods of estimating drag coefficients and wave attenuation. Predictive methods can be improved by gaining a better understanding of the complex interaction between fluid motion and the dynamics of flexible vegetation. In this work, seagrass blade dynamics were explored through numerical and laboratory experiments. In the numerical model, a single blade of seagrass was modeled as a series of rigid plates, which were attached by torsion springs in order to represent rigidity. In the laboratory wave flume, seagrass blades were modeled as strips of plastic. Phase-averaged velocities were measured with an acoustic velocimeter and blade positions were captured with a video camera. Most of the turbulence production was found to occur during blade pronation in the early part of the wave period, a finding that was used to develop a new method for predicting wave attenuation. Turbulence production during the first 60% of the wave period, representing the time during pronation, was accurately predicted by the maximum fluid velocity over the wave period. The relative contribution to the total turbulence production over the wave period was found to be a function of the relative strength of the waves and the current. By fitting a simple algebraic model to the numerical data, the total depth-integrated production over the wave period was accurately predicted by three simple parameters: the maximum fluid velocity over the wave period, a nondimensional comparison of the wave and current velocities, and a nondimensional parameter that compares the blade rigidity to the drag force. Using these three parameters, the algebraic model allows efficient estimation of wave attenuation and effective drag coefficient of flexible aquatic vegetation.

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THE TAGUS ESTUARY CASE, LISBON, PORTUGAL

The Tagus estuary in Lisbon, Portugal, has a relevant dimension, an impressive beauty and a rich biodiversity, but suffered the impact of growing population and industrial waste. Since the end of the 90ies, a global strategy has been implemented, with combined axes, to pursue a progressive improvement of the river water quality. An institutional reform was designed to put an end to the previous atomized intervention of several authorities and to aggregate all the relevant stakeholders on a regional level. Special agencies were designed to pursue technical goals, detailed plans and predefined levels of costs and tariffs. The governance comprehends also: a powerful sectorial regulator to keep under control the allocated investment and the related economic effort; (and) environmental regulators to ensure the discharge conditions and to monitor the sea water quality. The sewer system was completed with a network of interceptors parallel to the Tagus. WWTP were built under European directives, performing secondary or tertiary levels of treatment, according to the characteristics of the discharge areas. Planning was based on modeling studies on river and sea hydrodynamics, meteorological data and the predictable impact of WWTP discharges. The amount of investment was huge for a region with 2 million inhabitants, reaching 980 million USD. A specific monitoring system was designed to give on time information about the quality of the river waters. An important area of upper estuary was classified as a natural reserve, with stringent conditions to protect biotas. Positive results were attained, namely:
- the quality of the estuary and downstream beaches waters has improved; - biodiversity is giving powerful signs of revival, as it is the cases of the quality of some species of shellfish and of sea dolphins sightings in upper estuary, 30 km upriver; -Lisbon has turned again to the Tagus, bringing vast benefits for locals and helping a strong growth of tourism.

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IMPACT OF HYPOXIA ON HABITAT QUALITY OF PELAGIC FISHES IN THE NORTHERN GULF OF MEXICO

To evaluate the impact of hypoxia (<2 mg O2 l^{-1}) on pelagic habitat quality of pelagic prey fishes in the northern Gulf of Mexico, we used a spatially-explicit, bioenergetics-based growth rate potential (GRP) modeling approach to develop an index of habitat quality. Positive GRP was equated to high quality habitat (HQH) and negative GRP was equated to low quality habitat (LQH). We used bay anchovy (*Anchoa mitchilli*) and Gulf menhaden (*Brevoortia patronus*) as our indicator species. Our models used water temperature, dissolved oxygen (DO), zooplankton, and phytoplankton data as inputs that were collected during the peak periods of hypoxia in 2003, 2004, and 2006. Our results showed that hypoxic zones were always LQH. However, when the entire water column was considered, hypoxia had only a minor impact on overall habitat quality, with habitat quality being driven primarily by prey availability and then by water temperature. This finding stands in contrast to other ecosystems, such as the Chesapeake Bay, where hypoxia affects a large fraction of the water column and has a significant impact on overall habitat quality. Such differences in the effect of hypoxia on habitat quality between these two ecosystems point to the need to consider the vertical extent of hypoxia relative to water column depth, and may help to explain why obvious impacts of hypoxia on pelagic fish production are generally lacking.

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SPARTINA EXPANSION INTO MANGROVES IN SOUTHERN CHINA

Cordgrass (Spartina alterniflora) was introduced to China from the USA. It grows vigorously in China and has spread over much of the Chinese coast. Surveys in estuaries and coasts of southeast China have revealed a fast expansion of mangrove-Spartina ecotone, from Leizhou Peninsula (20°16'N) to Yueqing (28°20'N), a range of more than 8 degrees of latitude. Few studies have explored the causes and consequences of the encroachment of S. alterniflora into mangroves in China. Since spring 2011, we used a combination of monitoring and experimental transplants to study the distribution, growth, and interactions of native mangrove species and exotic S. alterniflora at 4 sites across latitude within mangrove-Spartina ecotone in southeast of China. The growth of S. alterniflora was less vigorous at low latitude, likely due to stress. Monospecific stands of S. alterniflora covered nearly all of the low-elevation and most of the mid-elevation area at high latitude site, but only occurred as small patches on the margins of mangrove forests and bare mudflat at low latitude site. On the contrary, the growth of transplanted mangrove seedlings generally increased with the decrease of latitude. S. alterniflora competitively inhibited growth of mangrove seedlings. The strongest relative interaction intensity between S. alterniflora and mangrove seedlings was found at the middle latitude site. These results illustrate the complexity of natural gradients and plant species in mediating plant growth and competitive interactions between mangroves and S. alterniflora. We still need a better understanding of how the mechanisms maintaining the mangrove-Spartina ecotone are affected by biotic and abiotic factors, and to predict how this ecotone is likely to change in the future.

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HIGH FREQUENCY MONITORING OF DOC AND DIC BETWEEN A SALT MARSH AND PLUM ISLAND SOUND

From the material exchange perspective, semi-diurnal tidal water movement provides a close linkage between salt marsh and adjacent estuary. This material linkage is the foundation of recognizing salt marsh and adjacent estuary as an integrated system. Previous studies are short in providing information about dynamics of inorganic and organic matter exchange in the salt marsh-estuary system in high temporal resolution. This gap is mainly due to lacking of accurate measurement of water flux and material constitutes in high temporal resolution field measurements. We have been utilizing reagent-free, low-cost and high frequency in-situ fluorescent probe to measure colored dissolved organic matter (CDOM) in a salt marsh within Plum Island LTER since 2011. In the season of 2013, we are going to improve the quality of CDOM measurement by using YSI EXO-2 Sonde with longer deployment duration and less uncertainty. With the help of accurate direct real time water flux measurement and lab analysis of lability, stable isotope signal (δ13C), and 3D excitation emission matrix spectroscopy (EEMs), a database of DOC quantity and quality exchanged between several comparative salt marshes and Plum Island Sound could be established to study the dynamics of DOC behavior in the salt marsh-estuary system. We will also deploy a SAMI PCO2 and SAMI pH probe from Sunburst Sensors to measure the DIC concentration in a 15min interval to assess the lateral inorganic carbon dynamics from a salt marsh sub-estuary. Coupling with the adjacent eddy flux tower monitoring vertical carbon exchange, this lateral inorganic carbon measurement could close the inorganic carbon exchange budget of a salt marsh and provide important information for the organic carbon dynamics driver and total carbon budget of salt marsh.

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IMPACT OF CLIMATE WARMING AND OCEAN CARBONATION ON EELGRASS (*ZOSTERA MARINA* L.)

Despite numerous successful adaptations to a submerged aquatic existence, seagrasses have high light requirements that make them vulnerable to anthropogenic disturbances. The paradoxical vulnerability results largely from their high reliance on dissolved aqueous CO2 for photosynthesis. The potential for rising atmospheric CO2 concentrations to have significant warming impacts on the global climate has long been recognized, but the potential impacts of the "other CO2 problem", also known as ocean acidification, have only recently begun to be appreciated. As with other impacts of climate change, increased concentrations of dissolved aqueous CO2 [CO2(aq)] in the oceans of the world will elicit both negative and positive responses among organisms, ultimately potentiating ecological losers and winners. We are exploring the response of eelgrass to increased CO2(aq) within the context of a warming coastal ocean using a combination of manipulative experiments, physiological/biochemical investigations and mathematical modeling. Experiments conducted during the summer of 2012 and 2013 revealed significant positive effects of CO2 enrichment on eelgrass growth, accumulation of mobile sugar reserves, shoot survival and vegetative shoot propagation, despite prolonged exposure to water temperatures exceeding 30° C. Rising CO2(aq) appears to increase the high temperature tolerance of plants by improving the Q10 response of photosynthesis relative to respiration, thereby maintaining positive carbon balance that facilitates higher growth rates and improved survival of vegetative shoots at high temperature. The response of these Chesapeake Bay populations growing near the southern limit of eelgrass distribution on the Atlantic coast are helping us gain predictive insight into how climate change may alter the geographic distribution of this critically important species in other coastal environments that may be subjected to multiple stressors linked to climate change.

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PHYTOPLANKTON ASSOCIATIONS AT THE LTER-MC STATION IN THE GULF OF NAPLES (MEDITERRANEAN SEA)

Coastal phytoplankton presents a remarkable variability as a consequence of complex patterns and relationships of hydrological parameters at the land-sea interface. Based on data collected since 1984 at the station LTER-MC, 2 nm off the city of Naples, we aimed at determining: i) whether species associations can be recognized in such a variable coastal environment; ii) what are the seasonal and interannual distributions of the associations; iii) how robust are those associations; and iv) what are the environmental parameters driving their occurrence. Using an r-mode clustering analysis of a reduced data-set of 80 species (70% diatoms), we identified seven main species associations. Some of them included species that were recurrent over the years in the same period, and generally exclusive to those periods. Other associations showed two peaks of occurrence, or a very prolonged period of presence or, still, no clear seasonality at all. Over the time series an increasing or decreasing trend was noticed for some of the associations, while for others there were no overall changes. The q-mode clustering of the samples produced comparable results, basically confirming the associations of the species obtained in r-mode. The occurrence of the different associations was mainly driven by the season (i.e., temperature), whereas parameters related to the coastal nature of the site (i.e., nutrients and salinity) showed to be important for associations with no clear seasonality. We suggest that this analytical procedure can be applied to other long time-series data-sets, in order to provide a homogeneous set of information and facilitate the comparison of phytoplankton patterns across different sites.

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