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ABSTRACTS

SOCITIES, ESTUARIES & COASTS:
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TIDAL PRISM MODELING OF PHYTOPLANKTON AND NITROGEN CONCENTRATIONS IN NARRAGANSETT BAY AND ITS SUB-EMBAYMENTS

A tidal prism model was developed to calculate temporal changes in the spatially averaged concentration of three state variables: phytoplankton, dissolved inorganic nitrogen, and detritus. Our main objective was to develop a model to help us understand the causes of phytoplankton and nutrient responses to temporal changes in nutrient loading and environmental factors. The physical part of the model includes water volume, water depth, tidal forcing, exchanges at the seaward boundary, freshwater inflow, detritus settling to the bottom, and the effects of seawater on salinity (for calibration). The chemical part of the model considers concentration, transformation, recycling, and bottom fluxes of inorganic nitrogen. The biological part examines phytoplankton growth under the effects of nitrogen, temperature, and light limitations, and phytoplankton mortality (including grazing). Also included are the organic carbon storages and flows in phytoplankton and detritus, which are related to nitrogen using the carbon to nitrogen ratio. This single box model is formulated on a spreadsheet and it can quickly simulate behavior in well-mixed systems over extended periods of time. It identifies the effects of parameter values on the state variables using a time increment of one tidal cycle. The model was calibrated for Narragansett Bay, RI, USA, and simulated for the bay and two nested sub-systems, Greenwich Bay and Greenwich Cove over a four-year period. Comparison with field observations verified that the model performed reasonably when checked against weekly and monthly data.

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DEVELOPMENT OF AN ATLANTIS ECOYSTEM-BASED MODEL FOR THE LOUISIANA-TEXAS CONTINENTAL SHELF

The Louisiana-Texas continental shelf experiences extensive seasonal hypoxia that is predicted to cause declines in the production of commercially and recreationally valuable fish and shellfish. Thus far, fishery declines across the continental shelf due to hypoxia have not appeared or have been limited in scope. In some areas of the shelf, relative fish biomass has increased by up to four-fold following reductions in shrimp catching efforts due to a combination of high fuel prices and cheap imported shrimp. To better understand the effects of hypoxia and other natural and anthropogenic forcing factors on fish population dynamics in this complex ecosystem we are developing an Atlantis ecosystem-based model for the Louisiana-Texas continental shelf. The model will track up to 60 groups including multiple benthic and pelagic fish groups, sea turtles, marine mammals, brown and white shrimp, squid, and multiple groups of benthic invertebrates. Model simulations will examine the direct and indirect effects, related to the spatial and temporal extent of hypoxia, on fish community structure and biomasses. Here we provide an update of the model development.

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HURRICANES’ EFFECT ON LITTERFALL PRODUCTION OF MAGROVE FORESTS IN THE YUCATAN PENINSULA, MEXICO

Litterfall is an important component of mangrove production related to ecosystem services such as nutrient cycling and coastal subsiding. Litterfall production in mangrove forests near the tropics is likely to be affected by hurricanes and tropical storms that decrease production by limiting mangrove forest height and structure. However, hurricanes can also deliver rainfall and nutrients, thereby increasing production by relieving nutrient limitations. In this study we test the effect of long-term hurricane impact on mangrove forest productivity by comparing litterfall rates from two years of data from seven sites distributed along the Yucatan Peninsula, Mexico. Each site has historically been affected by hurricanes at various frequencies and intensities. Our results show a mean litterfall rate for mangroves in the Peninsula of 2.5 ± 0.29 g d.w.m⁻².d⁻¹ (1.62 ± 0.14 to 3.63 ± 0.21 g d.w. m⁻².d⁻¹), which is moderate compared to other mangrove forests. Litterfall rates were variable among sites; sites at the lowest and highest spectrum of the hurricane frequency and intensity (i.e. infrequent and mild hurricanes and frequent and strong hurricanes) had lower litterfall. Those sites in the middle were subject to moderate hurricane frequency and intensity had higher litterfall, consistent with Odum’s Perturbation Theory, which proposes highest ecosystem productivity is achieved at moderate perturbations. The results from this study help understand the relation between mangrove and hurricane frequency and intensity and provide insight into the effect of a changing climate on mangrove productivity. Although it is still unclear whether hurricanes and rainfall will increase or decrease in the Yucatan Peninsula, our results show that either change will impact the productivity of mangroves in the region.

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LONG-TERM EFFECTS OF DITCH PLUGGING ON SALT MARSRES AND THE SUBSEQUENT DEVELOPMENT OF INNOVATIVE RESTORATION TECHNIQUES

Most East Coast salt marshes have been ditched since Colonial times either for salt haying or mosquito control. These ditches drain both surface and subsurface water from the marsh in order to increase salt hay production or reduce mosquito-breeding areas. One consequence of ditching is the loss of surface water habitat suitable for waterfowl, wading birds and shore birds as well as fish and crustaceans. Other consequences include changes in vegetation community structure. Ditch plugging, has been employed widely in East Coast Spartina marshes as a means of increasing surface water habitat on previously ditched marshes. Ditch plugs are formed by excavating peat from the surface of a salt marsh and packing it in a narrow portion of a ditch. Water then is impounded in the ditch channel on the upstream side of the plug. Small-sized bermos or “wings” have also been employed to increase a plug’s holding capacity and area of impounded water. We examined 2 physical soil parameters (bulk density, percent organic matter), interstitial hydrogen sulfide concentrations, groundwater levels, vegetation community, and above-ground biomass at ditched and unditched marshes at 2 sites each in Maine, Massachusetts and Connecticut in 2005. The study was repeated in 2009 with the addition of 1 unditched marsh (with natural creeks) in southern Maine. Ditch plugs were installed from 1 to 11 years prior to the study except at 1 Connecticut site where ditches had filled in naturally over a period of decades. Results are given in light of long-term consequences for maintaining peat integrity and salt marsh accretion processes in the face of sea level rise. As a result of the failure of ditch plugging to maintain high quality salt marsh traits, innovative, more self-sustaining restoration techniques were developed and are now in pilot application. Preliminary findings from the 2010-2011 pilot seasons will also be reviewed here.

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ENVIRONMENTAL DYNAMIC MECHANISMS FOR SEDIMENTARY STRUCTURE FORMED BY TYPHOON OVER COASTAL WETLAND, LUOYUAN BAY, CHINA

During the typhoon events, the strong tidal current, the intense wave action and the heavy rainfall, which form the special sedimentary structures different from normal weather conditions. In order to understand the mechanisms of the distinctive sedimentary structure caused by typhoon, in situ measurements of water level, tidal current speed and direction, wave height, wind speed and suspended sediment concentration were carried out using ADV, Electromagnetic Current Meter, miniature pressure sensors and Turbidity Meters at two sites over coastal wetlands in LuoYuan Bay, during the period when typhoon “FUNG-WONG” was impacting region. Moreover, several very shallow surficial sediments were collected before and after the typhoon landing. Analyzing the obtained data shows that the water inundation time increases, and the value of storm surge can reach 1.1 m; the variations of water current flow are very complicated, and the current velocity in the inner of Spartina alterniflora marsh is higher than that at the marsh edge. The effect of the typhoon on the SSC was highly significant, with the average SSC over the whole tide cycle reaching 7 times the values during neap tides. The decimase water height could reach 1.54 m with the maximum water depth of 4 m. The shear stresses at the two sites induced by typhoon current were much higher than those under the normal weather conditions, and the sediments were eroded through the whole tidal cycle during the typhoon landing. After the typhoon landed, with the decrease of impact intensity, the bottom shear stress decreased rapidly, which caused the suspended sediment settled quickly. During the typhoon landing, the heavy rainfall dropped the sediment when the tidal flat unemerged, and the rainwater sorted the fine sediment on the surface and transported seaward through small tidal creek, then the coarsened and worse sorted sediment was left and buried by the quick deposited sediment after the typhoon.
However, reproduction rates (birth rate - mortality rate) were negatively correlated with production/biomass ratios (P/B ratios) were positively correlated with temperature. As summer progressed (when water temperatures rose above ca. 17°C), gravid females were captured all year round, and their sizes were negatively correlated with temperature at capture. Brood size increased with female body length, and the size of all embryo stages within amarspum was also negatively correlated with temperature. Using data from the literature on growth and reproduction of Orientomysis spp. reared in laboratories, as well as this study’s data, we estimated daily production rates of O. japonica. Production rates ranged from 0.0 to 13.6 mg DW m⁻² day⁻¹ and were density-dependent, i.e., high in spring, and production/biomass ratios (P/B ratios) were positively correlated with temperature. However, reproduction rates (birth rate - mortality rate) were negatively correlated with temperature, and negative rates at higher temperatures (> ca. 15°C) caused mymys densities to decrease in summer. Therefore, longer warm seasons induced by climate change may lead to shorter high-density periods of mysids, which may affect coastal biological productivity and community structure.

AN EVALUATION OF THE WATER QUALITY STATUS OF GEORGIA ESTUARIES AND COASTAL WATERS USING RECOMMENDED INDICATORS

Water quality is a concern in many estuaries, and the U.S. EPA has mandated the development of nutrient nutrient criteria to assess the status of U.S. coastal waters. We have proposed a suite of seven indicators that are intended to help classify and understand the causes of water quality degradation in Georgia by covering the progression of eutrophication from nutrient over-enrichment to algal overgrowth (if present) to enhanced microbial respiration and hypoxia. Of these, we are able to assess four indicators using data collected by the Coastal Resources Division of the Georgia Dept. of Natural Resources during 2003-2006. pH status was assessed using dpH, the deviation from the expected pH according to the sample salinity and estuary type (alluvial/tidewater, Blackwater, alkaline Blackwater). Annual median pH deviations were classified as good at almost all sites in all years, whereas annual minimum pH deviations often ranged into the fair and poor categories. pH status generally improved from 2004 to 2006. Annual median dissolved oxygen (DO) was mainly good to fair, while annual minimum DO was mainly fair to poor, with sites classified as poorly occurring sporadically along the coast. DO status generally improved from 2003 to 2006. Annual median dissolved inorganic nitrogen status was mostly fair coastwide in all years, with the few sites classified as poor concentrated in the Altamaha River estuary. Annual median total dissolved phosphorus was fair coastwide during the study period. The generally poorer water quality in 2003 compared to later years may have been due to conditions related to high rainfall after a severe drought, although more years of data will be required to evaluate this idea. The results of this effort are being compiled into a brochure for broad distribution.

CATALESE, PEROXIDASE AND CHLOROPHYLL CONTENT IN THALASSIA TESTUDINUM BEDS IN THE INTERNATIONAL BIOSPHERE RESERVE SEAFLOWER

Coastal water nutrientification caused by anthropic activities is considered of the main causes of seagrass bed degradation and loss. The objective of this study was to analyze some biochemical characteristics of Thalassia testudinum, like protein concentration, total sugar content, catalase and peroxidase activity, and chlorophylls, as a response to coastal water nutrientification in San Andres Island, part of the International Biosphere Reserve Seaflower. We chose three sites with different salinity concentration (Bahiola, Bahia Honda and Harbor) and three with low impact of sewage discharge (Rocky Cay, La Mansión and Punta Hansa).

In each site samples were extracted every 5 m in a 10 m transect, for a total of 6 samples per site. Samples were taken during wet and dry seasons. We found no significant differences between seasons but there were significant differences among sites. Seagrass beds in B. Honda and Harbor have high total chlorophyll concentration (2,82-3,3 mg g⁻¹), high peroxidase (2,00 ± 102,30-102 UPD/μg protein in leaves) and catalase (44,91 ± 103-59,15 ± 103 UCAT/mg of protein in rhizome) enzyme activity. In all other beds, the chlorophyll content ranged between 0,88 and 2,18 mg g⁻¹, while peroxidase activity was 10,79-98,55 /mg protein in leaves, and catalase activity 12,58 ± 103-47,28 ± 103 UCAT/mg of protein in rhizome. In all the seagrass beds the protein (21,3-96,56 mg g⁻¹) and total sugar (7,32-27,24 mg g⁻¹) content in leaves was high suggesting that Thalassia is able to respond to nutrient impact. In B. Honda and Harbor (P<0,05) the high algal cover (surf and epiphytic algae) might be one of stress factors responsible for the high enzymatic activity.

INTEGRATING NEW TECHNIQUES FOR SALT MARSH RESEARCH WITH TRADITIONAL SEDIMENTOLOGICAL STUDIES: THE GROVES CREEK EXAMPLE

Salt marsh sedimentological and geomorphological research is traditionally a field-intensive effort. Informed sampling of the marsh environment, although aided in recent years by routine aerial image collection in coastal counties, has been complicated by the ability to embed observations within the context of widespread, fine-scale marsh geomorphology. New techniques in the past decade (i.e., RTK GPS, VRS networks, multibeam sonars, high-precision echo sounders) now provide a means to gather the requisite observations, although questions remain about the utility of some of these methods (i.e., LiDAR). The subtidal, intertidal and supratidal zones of the Groves Creek marsh near Savannah, GA, have been mapped at high resolution (± a cm), using the techniques described above, to provide the context within which sedimentological observations can be better interpreted. Groves Creek marsh is typical of Spartina alterniflora salt marshes of the southeastern U.S., with a stable elevation, numerous intertidal channels, and broad, vegetated supratidal marsh flats. Along a transect extending inland from the marsh edge, the following general characteristics occur: routine tidal differences occur from 0.6 to 7 mg/cm²/d. Be-7 distributions suggest 0.1 cm of sediment deposition per year, Pb-210 (100-y) accumulation rates range from 0.1 to 0.3 cm/yr and textural components average 5, 25 and 70 percent sand, silt and clay, respectively. However, these parameters do not trend in a uniform manner, and the explanation for the distributions is not obvious from aerial photographs alone. This talk will illustrate how...
detailed examination of general trends in micromorphology, sampling site elevations relative to sea level metrics and marsh subenvironment interconnectivity can provide critical insight into salt marsh sedimentological processes and products.

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MAPPING AND ANALYSIS OF SEAGRASS PROP SCARS IN GREATER SARASOTA BAY

Seagrass beds provide essential habitat and ecosystem services for the vast coastal estuaries of Florida. Historically, this important habitat has been in decline due to anthropogenic influences such as dredging, coastal development, run-off, eutrophication and boat hull and propeller damage. In Sarasota Bay, on the central Gulf coast of Florida, seagrass has rebounded in response to improving wastewater treatment practices over the last few decades. But with over 20,000 registered boats in Sarasota County and about 17,000 acres of bay water, shallow seagrass beds continue to be impacted by boat propellers. The cumulative damage to seagrass beds from repeated prop scar impacts can lead to significant habitat destabilization and loss. Analyses of prop scarring in Tampa Bay and Charlotte Harbor, adjacent to Sarasota Bay to the north and south, respectively, have been completed. However, this is the first analysis of this type for Sarasota Bay. This study results from the collaborative work of New College of Florida and Sarasota County Water Resources to map and analyze seagrass prop scarning in the Greater Sarasota Bay estuary. Seagrass prop scars were delineated and digitized from 2010 aerial orthophotography provided by the Southwest Florida Water Management District. Digitized prop scars were validated through ground-truthing of a random sample of scars in the field. Extent of scarring was quantified by clipping the polylines to grid cells and calculating the total length of scars in each grid cell. Implementation and refinement of this approach to mapping will create base data for comparison with other years of aerial imagery where prop scars will be digitized using the same standardized method. Results will identify “hot spots” of scarring requiring management or restoration, and change analysis between years may provide insight into rates of scarring and healing.

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COASTAL AND MARINE ECLOGICAL CLASSIFICATION FOR THE MADISON-SWANSON AND PULLEY RIDGE AREAS OF THE GULF OF MEXICO

Two components of the Coastal and Marine Ecological Classification Standard (CMecS) were applied to two protected areas (Madison-Swanson Marine Protected Area and Pulley Ridge Habitat Area of Particular Concern) located off the Florida shelf in the eastern Gulf of Mexico. CMecS, currently being considered for adoption as the national coastal/marine ecologic data standard by the U.S. National Oceanic and Atmospheric Administration (NOAA), builds on and integrates with existing U.S. standards. The CMecS domain extends from the coastal tidal splash zone to the deep ocean, including all bottom and water column features. CMecS has been implemented for several coastal areas but this is the first project in deeper shelf waters. Madison-Swanson, located at the margin of the continental shelf and slope, is used by an economically valuable reef fish species, the gag grouper. Pulley Ridge, a 100+ km-long series of N-S trending, drowned barrier islands on the southwest Florida shelf contains the deepest hagmatic scleractinian coral colonies in the continental United States. Madison-Swanson was closed to most fishing activity in 2000 to improve reproductive output and subsequently stock size of the grouper. Pulley Ridge was closed to most fishing activity in 2005 to maintain the biodiversity associated with the coral formations. For each area, CMecS Surface Geology Component (SGC) and Benthic Biotic Component (BBC) were used to characterize the associated habitat. The SGC is a first-order characterization of the fine-scale geology of the surface layers of the substrate, designed to be compatible with a range of observational tools. The SGC is a classification of the living biological aspects of the sealed within Marine Corps Base Camp Lejeune. Rising stage, bottles and sediment cups deployed across the marsh were used to determine availability of suspended sediment. Ceramic tiles affixed to the marsh surface were used to determine sedimentation rates across the study area. Preliminary data collected by these methods, as well as sediment plugs and topographic elevation data, indicate that maximum sediment availability and deposition occurs along a topographic low existing between the main tidal creek and uplands. The low bulk density of sediments in the topographic low coupled with surface flow and depositional patterns suggest the primary source of deposited sediment in the study area is this feeder creek and not the main channel of Freeman Creek. Consequently, efforts to determine material fluxes across the marsh surface should be designed to focus on the secondary drainages at this site.

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QUANTITATIVE COASTAL OBSERVATION AND MODELLING - TALES FROM AUSTRALIA

The purpose of this study is to quantify sedimentation patterns within the tidal salt marshes of Freeman Creek, NC, USA, and within soft sediment marshes of the transect from New College of Florida, Sarasota, FL, USA. The study area is a feeder creek and not the main channel of Freeman Creek. Consequently, efforts to determine material fluxes across the marsh surface should be designed to focus on the secondary drainages at this site.
today tend to be more poignant and relevant than re-running scenario years. Yet it is possible to modify the collated NRT inputs to develop new scenarios. Sensor network design in the coastal environment is maturing such that traditional concepts of sensor location and relative worth are being challenged when measured against higher volume, less accurate and less well placed clouds of sensors. It is challenging for more traditional observationalists to accept the argument of logistics over positional primacy, but progress is being made. New sensor technologies are being adopted to sample more of the biological elements of Australia’s coastal and estuarine systems, enabling the coupled sediment and biogeochemical models to be constrained and calibrated. This paper aims to present a snapshot of coastal and estuarine modelling undertaken using then CSIRO coastal environmental modelling suite and the associated observation schemes adopted, which range from the more traditional physical sampling to high density marine sensor networks.

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CLIMATE AS A DRIVER OF MANGROVE ECOSYSTEM CHANGE

On a geologic timeframe mangrove forests wax and wane, undergoing constant change as a result of fluctuations in sea-level in relation to long-term changes in shoreline evolution. Mangroves exhibit considerable resilience as a result of living in a continually changing, harsh environment, showing strong patterns of recovery from natural disturbances and a mosaic of arrested successional sequences in response to physical and chemical gradients and shoreline changes. However, the extent to which these adaptive traits predispose these tidal forested ecosystems to withstand predicted human-induced changes in climate, such as sea-level rise and increases in temperature and greenhouse gas concentrations, is unclear. Climate change will likely lead significant alterations of mangrove structure and function, but must be of secondary importance in comparison to current annual losses of 1-2% as a result of deforestation.

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CARBON DYNAMICS IN MANGROVE ECOSYSTEMS: A GLOBAL PERSPECTIVE

Carbon cycling in mangrove ecosystems has advanced to a stage where regional comparisons can be made as a first step towards understanding and predicting the flux of carbon in different types of mangroves under various environmental regimes. The largest flux of carbon is between the forests and the atmosphere but there are exceedingly few data of forest GPP. However, mangrove net primary production is well understood as is the movement of carbon from mangroves to the adjacent coastal zone. Recent global models indicate that a substantial amount of mangrove carbon is unaccounted for, but recent studies suggest that much of this carbon is mineralized and lost via groundwater or lateral transport rather than via simple surface flow. If true, then we can expect clear differences in the flow of carbon from mangroves to the adjacent coastal zone on the basis of tidal regime and based on estimates of forest productivity.

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EFFECTS OF COMBINED WARMING-NUTRIENT ENRICHMENT IN A SHALLOW-WATER SEDIMENT SYSTEM

The effects of global warming in combination with nutrient enrichment on a temperate shallow–water sediment system were investigated. We used natural intact sediment cores incubated in a flow-through system under close to natural light conditions. The sediment was exposed to either seawater at ambient temperature or seawater heated 4°C above the ambient. For the nutrient enrichment we used pellets that are normally being used in commercial agriculture. We measured both structural (algal biomass and composition) and functional variables (primary production, community respiration, sediment-water inorganic and organic nutrient fluxes, denitrification and remineralization of nitrogen). The effects of temperature and nutrient-enrichment were complex, varying with time, day/night and response variable. Single factor and factor-time interactions were more common than interactions between temperature and nutrient enrichment. Denitrification and primary production increased in response to a nutrient enrichment whereas community respiration increased with temperature. Inorganic nutrient fluxes responded similarly with the exception of phosphorus, being affected by both temperature and nutrients. Integrated community response was analyzed using multivariate statistics (PERMANOVA). The results separated the main factor effects and interactions between light and dark processes, indicating an additive response of autotrophic processes and non-additive (synergistic/antagonistic) response of heterotrophic processes. We also investigated the mode of stressor interaction by calculating stressor effect sizes. For all measured response variables, stressor effects were mainly additive, although there were trends of shifts from synergistic to antagonistic effects with time. When warming and eutrophication act simultaneously they appear to induce both additive and non-additive effects that vary with time and season.

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RECREATIONAL FISHING TRIGGERS A TROPHIC CASCADE AND COLLAPSE OF A MARSH ECOSYSTEM

Overexploitation of predators has been linked to the collapse of a growing number of shallow water marine ecosystems. However, salt marsh ecosystems are still viewed and managed as systems controlled by physical processes despite recent reports of consumer driven die-off of marsh vegetation. Here, we use field observations, experiments, and historical records to show that the recently reported die-off of Northwestern Atlantic salt marshes is a consequence of recreational overfishing. The localized depletion of top-predators at sites accessible to recreational fishing has triggered the proliferation of herbivorous crabs which in turn results in runway consumption of marsh vegetation. This suggests that overfishing may be a general mechanism underlying the consumer-driven die-off of salt marshes spreading throughout the Western Atlantic. Our findings support the emerging realization that consumers play a dominant role in regulating marine plant communities and can lead to ecosystem collapse when their impacts are amplified by human activities including recreational fishing.

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COMPOSITION OF INORGANIC AND ORGANIC NUTRIENT SOURCES INFLUENCES PHYTOPLANKTON COMMUNITY STRUCTURE IN THE NEW RIVER ESTUARY, NORTH CAROLINA

The microtidal New River Estuary (NRE), NC exemplifies the negative effects of anthropogenic nutrient enrichment, including toxic algal blooms, hypoxia, fish kills, and benthic habitat degradation. The NRE receives external nutrient inputs from a variety of sources, including agriculture, municipal wastewater, the atmosphere, and groundwater. These sources supply varying forms of nitrogen (N), including nitrate, nitrite, ammonium, and dissolved organic N (DON). In order to better understand phytoplankton growth responses to river DON and inorganic nutrient sources, growth response parameters were examined in multiple nutrient addition bioassays. Biosassays utilized natural phytoplankton communities grown under natural light and temperature conditions. Treatments included inorganic N (ammonium and nitrate); river filtrate (DON-rich water taken from upstream location on New River); urea; phosphate(P); and dual inorganic N and P treatments. Growth response parameters included biomass (chlorophyll a concentration), primary production (14C method), and community composition (HLFCA analysis of diagnostic pigments and microscopic cell counts). Results indicate that chemical composition of nutrient sources does influence growth of phytoplankton taxa differentially, thereby shaping phytoplankton community composition. The summer 2010 bioassay exhibited distinct community responses to varying nutrient forms with the P addition eliciting a bloom response by nitrogen-fixing cyanobacteria (Anabaenopsis sp.). Additionally, an increase in dinoflagellate biomass was observed in the river filtrate treatment, indicating that components of the DON pool in river filtrate may be used or even preferred by this group of phytoplankton. Community responses to nutrient treatments were highly seasonally variable, underscoring the importance of environmental conditions (ie. prior inorganic nutrient ratios, salinity, temperature, light, turbidity) in mediating phytoplankton nutrient resource use.

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MYA ARENARIA SHELLS REVEAL CHANGES IN SURFACE WATER TEMPERATURE AND PRIMARY PRODUCTIVITY IN THE GULF OF MAINE OVER THE LAST 4400 YEARS

Valuable palaeoenvironmental data can be derived from bivalve shells. The Turner Farm shell midden on North Haven Island in Penobscot Bay, Maine, has a record of occupation over the last 4400 years. We examined the shell geochemistry of Mya arenaria shells from between 3 and 30 individuals per sample to derive temperature and primary productivity in the Gulf of Maine over the last 4400 years. We measured carbon and oxygen isotopes in the shell material. Temperature, expressed as δ18O and δ13C, ranged from 7.6 to 8.9 oC over the last 4400 years B.P. During the last 1200 years, temperature was coldest (8.4°C) 500 years B.P. and warmest 2000 years B.P.
1200 years B.P. (9.2°C), possibly reflecting the Little Ice Age and early Medieval Climate Anomaly respectively. These temperature estimates assume a constant salinity of 30‰, which is the multi-year average (2002-2007) from a nearby oceanographic buoy. Past salinity variation, however, likely explains some of the variability in the δ18O values. On going work is investigating the utility of the ratio of Lithium to Calcium in Atya shells as a potential paleotemperature independent of salinity. Organic material in the shell matrix was significantly depleted in 13C in 1200 and 1200 years B.P. compared to modern shells. The most parsimonious explanation for carbon enrichment in modern shells (δ13C = −21.0‰, including the Suess effect of 1.5‰) vs. shells from 1200 (−24.73‰) and 3300 (−23.67‰) years B.P. is an increase in near-shore primary productivity. We are also investigating shell elemental ratios (e.g. Ba/Ca) as a potential proxy for productivity to support this explanation. We feel a multi-proxy approach will provide the best insight into the Gulf of Maine paleoenvironment.

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MONITORING POST-OIL SPILL RECOVERY OF COASTAL WETLANDS USING NON-INVASIVE TECHNIQUES

Following the April 2010 Deepwater Horizon spill, approximately 688 km of Louisiana’s shoreline were exposed to oil, 275 km of which consisted of Spartina alterniflora-dominated marshes in Barataria Bay. Although oiled stems were matted down and killed, new young S. alterniflora stems were observed growing in exposed areas within two months of the spill. Monitoring the recolonization of these marshes required remote sensing techniques to avoid causing any further disturbance. Twenty sites, spanning four levels of oil exposure as reported by Shoreline Cleanup and Assessment Teams, were monitored on a monthly basis beginning in February 2011. Percent cover of living stems was quantified using digital spectral classification of oblique and aerial photographs of the sites. Shoreline retreat rates were calculated with laser distancing from fixed points near the sites. As of May 2011, no significant differences in percent cover have been found among the four exposure categories; however, no final conclusions can be drawn until monitoring is completed in September 2011.

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FOLIAR NUTRIENT DYNAMICS OF FORESTED WETLANDS ALONG A TIDAL GRADIENT ON THE APALACHICOLA RIVER, FL, USA

Hydrology is understood to have a critical influence on wetland characteristics and processes. As riparian forests transition from tidal to non-tidal conditions there is expected to be related shifts in wetland assimilation and retention of nutrients. Foliar nutrient dynamics were studied at 8 forest stands (three non-tidal and five tidal) along the lower 30 km of the Apalachicola River system in Florida, USA. Canopy foliage and litterfall from representative overstory species were analyzed for a variety of elements including N and P. We examined differences in element concentrations, nutrient ratios (C:P, C:N, and N:P), nutrient use efficiency, and nutrient productivity between tidal and non-tidal forests. All wetlands showed evidence of P limitation, but absolute levels of P were determined to be extremely low in tidal wetlands based on higher nutrient use efficiencies (measures of both P resorption efficiency and productivity). Differences in P concentrations and fluxes between tidal and non-tidal wetlands are likely due to longer inundation and hydrologic export observed in tidal wetlands. Diameter at basal height (DBH) at each study plot was used with specialist equations to estimate forest litterfall dry weight and N and P flux in non-tidal and tidal wetlands. Using estimations of annual litterfall dry weight and nutrient concentrations, N and P flux in non-tidal swamps was 2-4 times greater than in tidal wetlands. Differences in N and P use efficiency, and nutrient productivity between tidal and non-tidal forests are likely due to longer inundation and hydrologic export corresponding to correspondently, the most throughfall variability. We observed tree morphology and canopy diversity at several sites contributed to exaggerated throughfall totals, often exceeding gross rainfall. Throughfall rain is typically the largest component of the rain transfer budget related to canopy interception of gross rain. However, stemflow, evapotranspiration and canopy storage are also needed to determine the water budget. Therefore, we have added stemflow collection (Spring 2011) to each transect and incorporated ancillary evapotranspiration data to assist in developing a realistic mangrove rainfall interception and water budget model.

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THE ROLE OF NATURAL AND ANTHROPOGENIC DISTURBANCES IN REGULATING THE BENTHIC NUTRIENT FILTER

Shallow photic estuaries vulnerable to anthropogenic and natural disturbances are somewhat protected by the activity of benthic microorganisms, which play an important role in retention of remineralized nutrients and regulation of benthic–pelagic nutrient exchanges. The effectiveness of the benthic nutrient filter depends on climatic variables, including fresh water discharge, wind, temperate, and light availability. We examined the effects of seasonal and inter-annual climatic events on benthic photic area, chlorophyll, metabolism, and nutrient fluxes in the New River Estuary, NC, surrounded by Marine Corps Base Camp Lejeune and the city of Jacksonville. Photic area of the estuary was calculated based on a multiple regression model relating Kd to water column chlorophyll a, chronophotodissolved organic matter, and turbidity. Freshwater discharge, air temperature, and wind direction were all significantly related to photic area. Spring benthic chlorophyll biomass was lowest in a year with greatest freshwater discharge. Benthic gross primary production and net community production, an important indicator predicting nitrogen (N) flux to the water column, were directly related to benthic chlorophyll biomass. A net autotrophic benthos took up N; a net heterotrophic benthos released N. Gross remineralization, an important internal source of N supporting benthic and summertime pelagic production, varied seasonally and in response to local anthropogenic watershed disturbances. The ability of benthic microorganisms to modulate release of remineralized N to the water column was regulated by climatic drivers, which varied on seasonal and inter-annual time scales and a determined light availability to the benthos. The threshold of light availability, which switches the benthos from net autotrophic to heterotrophic and from a net sink to source of N, must be considered when developing water quality management strategies for shallow photic estuaries.

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JUVENILE ASCARIDOID NEMATODES AND FOOD WEBS IN THE GULF OF MEXICO AND LESSER ANTILLES

Parasitic nematodes of the family Anisakidae (Ascaridoidea) have complex life cycles, yet juveniles are difficult to distinguish to specific and sometimes to generic level because they have similar morphological features. In this study, we stress that identification of juvenile ascaridoids in the Gulf of Mexico and Lesser Antilles using the ribosomal DNA internal transcribed spacer (ITS) ITS-1, 5.8S, and ITS-2 regions, provides more specific information than morphological descriptions. We examined around 180 fish species, 8 cephalopod species, and 5 crustacean species from estuaries, near shore, continental shelf, and continental slope habitats. Of those, approximately 110 fish species and 3 species each of cephalopods and crustaceans served as either an intermediate or paratenic host for ascariid nematodes. We found members of four genera, in three functional groups: those that mature in a cetacean (four species of Anisakis), in an avian (three species of Contraucus), and in a fish (two species of Hysterothylacium and two species of Raphidascaris). We collected (two species of Hysterothylacium spp. and Raphidascaris spp. infected more fish than members of the other genera because they have a fish final host. One species of Hysterothylacium collected from fishes living in estuaries, near shore, and continental shelf probably passes through higher-level, predatory, fish, paratenic hosts as the inshore parasite was transferred, in turn, to progressively more offshore fish host species. We collected Contraucus spp. from a continental shelf/slope fish species, indicating the importance of birds in the food web.
web of a deeper fish species. Our results suggest that using the ITS genes from juvenile nematodes can provide clues into the connectivity of marine food web. Moreover, our results show that fish from a variety of habitats are infected by different ascarioids that pose a human health risk. Funded by NSF No. 0529684, NOAA OHHI NA08OAR4730322, and BOEMRE/CAP MS R.798.

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ANALYSIS OF THE ECOSYSTEM SERVICES FROM FORESTS OF THE TAMPA BAY WATERSHED

The forests the Tampa Bay Watershed (TBW), a coastal subtropical region in Florida, are changing in part due to an increase in population and an expansion of urban areas. These changes, in extent and structure, are raising concerns about the loss of services derived from the forest. In 2007, we established 500 permanent plots, in a systematic random sample, to begin quantifying the urban and urbanizing forests of the TBW. Using the data from these plots, we are able to describe forest species composition, size class distributions, canopy cover and other commonly calculated forest metrics. In addition to these values, we used the i-Tree Eco model to calculate values for some of the environmental services provided by the forests including: carbon sequestration, energy conservation, and pollution reduction. Since 2010, we established or are in the process of establishing an additional ~300 new permanent plots in the watershed. We are developing tools to link ground based data with satellite imagery to model forest structure and composition at the landscape scale. In 2011, we initiated the process of re-measuring 200 of the original plots that were located within the city of Tampa. This will provide information about 5-year rates of change (biological growth and land use change) so that we can begin to simulate and model the dynamic nature of ecosystem services on a temporal scale. The existence of this robust data set has generated partnerships with research and government institutions interested in a wide range of social and ecological investigations including water quality and quantity concerns. This long-term study is providing empirical data for the development of models that incorporate land use change with the biological functions of the forests in a range of structural conditions. Such models will provide managers and decision makers with tools for the development of sustainable forest management strategies and policies in a rapidly urbanizing region.

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NUTRIENT TRANSPORT AND TRANSFORMATION IN A TIDALLY INFLUENCED SUBTERRANEAN ESTUARY

Increasing development and population growth along coastlines worldwide has lead to elevated levels of nutrients in coastal aquifers. Nutrient loading from these aquifers to coastal waters depends not only on the landward sources but also the specific nutrient discharge pathway and the biogeochemical reactions occurring along this pathway. In particular, the flow, transport and transformation dynamics in a subterranean estuary strongly control the exit conditions for nutrients discharging to receiving coastal ecosystems. In this study a numerical model is presented that investigates the influence of tides on the fate and transport of nutrients in a subterranean estuary and subsequent fluxes to coastal waters. While the fate of nutrients in subterranean estuaries has been well studied, the impact of oceanic fluctuations including tides is often neglected. These fluctuations however create a dynamic mixing and reaction zone in the near-shore aquifer and significantly alter the subsurface flow paths for discharging nutrients. The variable density groundwater flow model SEAWAT is used with the reactive multi-component transport model PHT3D to simulate the transport and transformation of land-derived nutrients including nitrate, ammonium and phosphate. Reactions considered include denitrification, nitrification, oxide degradation of dissolved organic carbon and iron oxidation and reduction. The effect of tide-induced mixing between anoxic groundwater and oxic seawater on the fate of nutrients in a subterranean estuary is examined. Simulations show that tidal fluctuations significantly influence the nutrient dynamics and governing parameters are explored.

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FACTORS AFFECTING RED MANGROVE (RHIZOPHORA MANGLE) PROP ROOTS AS HABITAT FOR OYSTERS (CRASSOSTREA VIRGINICA) IN THE INDIAN RIVER LAGOON

The ecological benefits of oysters include value as habitat for fish and small invertebrates, improving water clarity by filtering seston from the water column, providing habitat for smaller organisms and serving as a food source for predators and humans. In the Indian River Lagoon (IRL), one of the major habitats for the eastern oyster, Crassostrea virginica, is prop roots of red mangroves, Rhizophora mangle. The ecology of this system is poorly understood. We conducted an exploratory observation study of oysters attached to red mangrove prop roots throughout the IRL. The study is an analysis of the direct and indirect effects particular physical and biological factors have on these mangrove-residing oysters. We linked oyster abundance, size, and proportion alive to direct and indirect affects particular physical and biological factors having use structural equation modeling. The oyster variables, size of individual oysters, number of oysters, mortality rate of oysters and oyster clump size, were examined. Physical factors included salinity, chlorophyll a, distance to inlet, distance to discharge source, amount of mangrove shoreline within 1 km, and how seaward the prop root was located. Using an exploratory structural equation modeling we tested how the structural characteristics either directly or indirectly represent the latent variable “oyster.” “Oyster” was measured by three variables; proportion live oysters, total number of oysters, and maximum diameter of clump. This study is the first to investigate the oyster habitat of red mangroves, an ecologically critical habitat. Currently additional data is being gathered on habitat that has been directly altered by human actions; impounded red mangroves, seawalls and piling.
In a time of accelerating rates of sea-level rise and ever-increasing anthropogenic pressure, the gross geomorphology of coastal wetlands has become increasingly important. If salt marshes can more accurately evaluate rates comparable to sea-level rise, effective management requires information about the timing and pattern of potential inundation. In site-based studies, the upland-channel geomorphological profile of salt marshes is determined based on topographic transect data. These data are often biased by accessibility, channel avoidance, and the primary goals of the study, and may not be a good measure of the overall distribution of elevations throughout the wetland. At Wellesley College, a team of 7 undergraduate scientists employed GIS analyzes of LiDAR data to create generalized elevation profiles, based on frequency analysis, for coastal wetlands along the U.S. Atlantic seaboard from Maine to Florida. These profiles give a sense of wetland vulnerability and likely response patterns. They are further analyzed relative to tide range, climate, vegetative zonation, geologic setting, size and anthropogenic impact. Students digitized geomorphologic features such as ditches, ponds, and pannes to assess wetland form and function. We find that northern salt marshes exhibit platform morphology, while many (but not all) mid-Atlantic and southern wetlands have a ramped profile. Data from this and related GIS studies of wetlands may inform management decisions and adaptation strategies in light of changing climate and coastal norms.

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THE ROLE OF TIDAL OSCILLATORY SALT FLUX IN DELAWARE BAY ESTUARY

Numerical simulations of Delaware Bay suggest that the along-channel area integrated tidal oscillatory salt flux plays a significant role in the landward advection of salt fluxes in this system. To investigate the mechanisms driving the tidal oscillatory salt flux we are conducting field measurements in Delaware Bay. The field program consists of a cross channel array of 6 moorings, two moorings upstream and downstream from the main array, and a series of tidal cycle surveys at the location of the mooring array. Our initial analysis will use conventional methods to decompose the along channel salt flux from the moored and ship board data in order to quantify the tidal oscillatory salt flux. In addition these results will be placed in context with a salinity-class transport analysis proposed by MacCready et al. Results from these methods, applied to both the observational data and model output, will be compared and interpreted with the objective of understanding the mechanism behind the tidal oscillatory salt flux and to evaluate the function of channel-shoal morphology in driving this flux.

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METAPOPULATION DYNAMICS IN ESTUARINE HABITAT RESTORATION: DO REFERENCE AREAS ACT AS SOURCE POPULATIONS?

Consideration of metapopulation dynamics in habitat restoration can help to identify suitable source populations to supply restored areas. Metapopulation theory stipulates that source populations will have positive intrinsic growth rates; therefore, we predicted that aquatic faunal populations in reference (source) areas would have higher intrinsic growth rates than in restored (sink) areas. Second, a metapopulation exists if patches of habitat are connected and are suitable for colonization; therefore we predicted that organisms would disperse and colonize restored areas where the habitat was suitable. To test these hypotheses, we monitored habitat characteristics and densities of three common aquatic species (salinif mollusc Pectinaria latipina; rainwater killifish Lucania parva; grass shrimp Palaemonetes pugio) in three patches of recently restored brackish marsh and one reference area in the northwestern Gulf of Mexico from 2008 to 2010. All habitat patches were connected by a network of permanently inundated channels. Faunal densities were constant over time in the reference area but increased in most of the restored areas. This suggests either that (a) the reference area served as a source population that supplied the restored areas with recruits or (b) the intrinsic growth rate was higher in restored than in reference areas. We used principal components analysis to define threshold suitability values for key habitat characteristics. Only Poecilia density was significantly related to habitat characteristics in the reference site, but Poecilia densities were not higher in restored areas with ideal habitat features than in unsuitable restored areas. Therefore, habitat suitability did not appear to be the primary driver influencing faunal colonization of restored habitat. Our results suggest that metapopulation dynamics were not strongly influencing restored site colonization at this spatial scale.

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LATERAL STRUCTURE OF TURBULENT DISSIPATION IN AN ESTUARY FROM NEAP TO SPRING TIDES

High-resolution hydrographic data were collected along a 2 km transect of the James River during four semidiurnal (~12 hr) tidal cycles to determine the lateral structure of turbulent kinetic energy dissipation. Hydrographic profiles were collected at four stations with a Self Contained Autonomous Microstructure Profiler (SCAMP) and were used to calculate turbulent kinetic energy dissipation (via Batchelor Spectrum fitting). Neap tidally averaged contours of turbulent dissipation rates ranged from 10^{-5} to 10^{-6} m/s^2 and displayed large values near the bottom and peak values in the channel. The location of the peak TKE dissipation rates varied between neap and spring tidal modulations as well as between the two spring tide surveys. During spring tide, the values ranged from 10^{-5} to 10^{-6} m/s^2 and featured the large dissipation rates near the surface and the bottom. A pattern was observed during the spring surveys that connected the location of the peak dissipation values with the wind direction. The first survey displayed large values of dissipation at the surface and bottom of the north-east side of the cross-section. The maximum rates of dissipation were located at the abruptly sloping north-east channel wall and were an effect of moderate winds from the north-east (~6 m/s). Conversely, the second survey showed large TKE dissipation values near the bottom of the cross-section and at the surface over the shoals. Similar to the first spring survey, the peak values of dissipation were located near the bottom of the south-west shoal and corresponded to the winds from the south-west (~5 m/s). These observations are among few that investigate the lateral structure of turbulent dissipation in an estuary and suggest that the spatial distribution is influenced by the proximity to the bottom (where velocity gradients are generated by frictional effects), tidal flow regions that generate large velocity shears and impacts from wind variability.

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RESPONSES FROM SUBTROPICAL SEMI-ARID COASTAL LAGOONS TO ANTHROPOGENIC AND NATURAL INFLUENCES

We observe responses from the functioning of three restricted coastal lagoons to anthropogenic and natural influences. Guaymas, Guasimas, and Rancho lagoons are localized on the Eastern Gulf of California, Mexico, a semi-arid subtropical region. These systems are shallow (~2 m deep), have short residence times (~6 days), water temperature (16 – 33 °C), Salinity (32-38), and Dissolved Oxygen (~4 mg l-1 around year. Cases of wastewater inputs, it had lesser Salinity (< 36) and Dissolved Oxygen (summer < 5 mg l-1) that 2008; 1996 has higher DIN, DIP and Chlorophyll-a that 2008; trophic state changed from mesotrophic (1996) to the oligotrophic (2008). (2) Guasimas lagoon, in scenarios without (2000), and with shrimp effluents (2005), showed residence times from 3.5 days (2000) to 10 days (2005). Lagoon was source both 2000 and 2005 of Phosphorous (ADIP), but sink during 2000 and source during 2005 of Nitrogenous (ADIN); denitrification processes dominate in both years; trophic state, changed from oligotrophic (2000) to mesotrophic (2005). (3) Rancho lagoon, receives shrimp effluents from April to October, influence by shrimp effluents showing both a nutrients export rate, and an increase from respiration rate that doing dominate denitrification processes, also maintaining anthropogenic contamination metabolism during summer. In addition, there is evidence that coastal upwelling on this region have an important seasonal role by increasing both nitrogen import and organic matter rates to ecosystems.

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FIRST AND SECOND ORDER CONFLICTS: MEASURING THE LIVED EXPERIENCE OF INTERACTIONS BETWEEN FISHERS AND GREEN TURTLES IN THE LAKSHADweep SEAGRASS LAGOON

Though human-wildlife conflict is recognized as a crucial impediment to conservation, the science of conflict has not gone beyond contextual documentation to a more conceptual understanding of its drivers. Conflict studies normally document its most obviously quantifiable metrics including deaths and economic losses. These measures often do not match with community perceptions of the lived experience of conflict, begging the question of what drives this difference. We examined conflict in the Lakshadweep Islands, where
fishers blame herbivorous green turtles (Chelonia mydas) for a decline in fish catch. We worked with fishers coming together in Agatā to deconstruct perceptions and understand its drivers. Fishers proposed several explanations for their perception that turtles reduce fish catch. While fishers identified gear damage and other direct losses as mechanisms for reduced catch, it does not account for the degree of antagonism against turtles. Importantly, fishers claimed that turtles overgraze seagrass, thus reducing adult fish abundance and recruitment to the meadow. While the first set of mechanisms (gear damage and disturbance) represent direct impacts, quantifiable in terms of economic loss and opportunity costs, the second (overgrazing, reduction in fish abundance and recruitment) invokes more indirect pathways, contingent on the ecological impacts of turtles on meadow function and fish communities. We classify these as first direct) and second order (indirect) conflicts. We briefly present results of our ecological evaluations of these second order perceptions. We argue that second-order interactions may be commoner than are recognized, being typically difficult to confirm, driven by complex ecological and/or social mechanisms. A wider multidisciplinary approach is required to understand them and bridge the gap between scientific measurement and a community’s lived experience of conflict.

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CHANGES IN HUMAN HEALTH AND WELL-BEING RESULTING FROM THE DEEP WATER HORIZON OIL DISASTER

Human well-being provides a measure of the quality of life experienced in many countries, regions and cities. However, these measures are often based on economic indicators and lack consideration of social and cultural factors, environmental health, ecosystem services, and human health. A central goal in this area of research for coastal resource management agencies is to develop a comprehensive index of well-being that is reflective of environmental health and ecosystem service provisions to quality of life. The purpose of this study is to establish a baseline for monitoring changes in the health and well-being of residents along the Gulf of Mexico in counties impacted by coastal contamination from the Deepwater Horizon industrial disaster. Using social science data we will establish indicators of public health and well-being in coastal counties. Over the long-term, the study could be replicated at intervals to monitor changes in public health and well-being to assess the recovery of coastal communities impacted by the disaster. Using indicators of environmental health developed by federal, state and academic programs, we will also examine changes in ecosystem services to help us understand the links between the general health and well-being of communities and changes in the environment. The study will be focused on coastal counties directly impacted by oil contaminated shorelines, as well as a selection of comparison counties. Work to date will be described including indicator development, data collection and preliminary analyses will be described.

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MITIGATING LOGGERHEAD SEA TURTLE (CARETTA CARETTA) NEST TEMPERATURES IN RESPONSE TO CLIMATE CHANGE

Sex determination for marine turtles and many other non-avian reptiles is temperature-dependent. Increasing nest temperatures of the loggerhead sea turtle (Caretta caretta) throughout Florida has led to an increased bias towards female hatchlings. This female bias is expected to become greater due to climate change. Using shade to reduce nest temperature and increase the proportion of male hatchlings is one option for mitigating the impacts of climate change on marine turtle sex ratios. This study provides preliminary data on the thermal and moisture effects of shading sand with a cotton shade cloth attached to the top of a predator control self-releasing cage. A comparison is made between three treatments: un-shaded loggerhead nest, un-shaded sand, and shaded sand. The study site is at Canaveral National Seashore, an important rookery for loggerhead sea turtles.

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STABLE ISOTOPES AS DIETARY INDICATORS IN NORTHERN GULF MANATEES: UNDERSTANDING FRINGE HABITAT USE

The West Indian manatee (Trichechus manatus) is a highly mobile aquatic herbivore. Although manatees are regular seasonal residents of the northern Gulf of Mexico (nGOM) coast, little is known of manatee habitat use in the area. We used N and C stable isotope (SI) ratios in potential foods and manatee tissues to trace dietary sources of nGOM manatees. We analyzed tissues from live and dead animals to determine the utility of using stable isotopes from carcasses when samples are not available from live manatees. Tissue SI ratios indicated mainly freshwater and estuarine dietary sources for live manatees, consistent with the location of their capture, but tissues from carcasses reflected a greater marine influence. These results suggest that manatees that died in nGOM waters had different travel and habitat use preferences compared to animals captured alive. The role of postmortem tissue decomposition on tissue SI ratios is also considered. Management and conservation strategies should recognize that nGOM manatees in marine-influenced areas may be more vulnerable to seasonal stressors and mortality than conspecifics utilizing inshore habitat.

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APPLICATION OF A NOVEL METHODOLOGY FOR ASSESSING CLIMATE CHANGE VULNERABILITIES OF WETLANDS USING EXPERT JUDGEMENT: RESULTS FOR SAN FRANCISCO BAY AND MASSACHUSETTS BAYS

The San Francisco Estuary Partnership and the Massachusetts Bays Program have partnered with EPA’s Climate Ready estuaries program to assess key vulnerabilities to climate change. We present the results of two ecological vulnerability assessments that demonstrate a novel methodology based on expert judgment designed to inform adaptation planning. For each pilot, two ecosystem processes were examined through expert elicitation workshops: sediment retention in salt marshes and community interactions. Community interactions explored for San Francisco Bay included shorebird-mudflat prey interactions, while the focus for the Massachusetts Bays was salt marsh grasses-salt marsh sparrow interactions. After creating influence diagrams showing the relationships among key process variables, the experts generated information on which relationships may show, under future climate change: 1) increasing relative impact on the overall process; 2) increasing sensitivity; and 3) abrupt threshold changes. Using the experts’ judgments on the sensitivities to future climate conditions, we identify “top pathways” for which there are available adaptation options. Three top pathways for each ecosystem process will be discussed, with accompanying evaluation of adaptation options for management. Relating top pathways and associated adaptation options to existing management activities is a path forward for adaptation action. The results will help managers identify win-win options and research gaps, weight trade-offs, and prepare for threshold shifts and other long term changes.

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HOW LOW CAN IT GO? THE CHESAPEAKE BAY SHALLOW WATER DO LIMBO STICK

Starting in 2003 (and in subsequent updates) the U.S. Environmental Protection Agency (EPA) established dissolved oxygen (DO) criteria for the Chesapeake Bay and its tidal tributaries. EPA defined habitats based on designated uses and tailored DO criteria to account for different spatial and temporal conditions. Numeric criteria were developed for monthly, weekly and instantaneous DO concentrations. Until the last decade, water quality monitoring in Chesapeake Bay and tributary rivers was largely based on monthly or bi-monthly sampling at fixed stations located over the deeper (channel) portions of these systems. This design was helpful for developing seasonal and inter-annual scale indices of water quality status and trends, but inadequate for addressing habitat criteria for shallow near-shore areas. About 10 years ago a new program was initiated to add measurements of water quality in shallow waters focused on submerged aquatic vegetation (SAV) habitat quality. The program was named ConMon to indicate the near-continuous monitoring feature of the methodology. The program uses in-situ sensor systems (YSI Sonde) designed to take measurements of a suite of water quality variables every 15 minutes. Included in the water quality suite are water temperature, salinity, pH, DO, turbidity and chlorophyll-a. The considerable spatial extent (encompassing sites with water quality varying from quite good to very poor) of these sites allows for comparative analyses where relationships between near-sea water quality and management actions can be found. Analysis of ConMon data showed in shallow water habitats the primary factors controlling dissolved DO dynamics and criteria failure were algal biomass, water temperature and light attenuation. In addition, DO criteria failures were more common in areas proximal to large diffuse and point sources of nutrients, especially nitrogen.

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EAT A CLAM, SAVE THE WORLD: CARBON SEQUESTRATION IN BIVALVE AQUACULTURE

Biogenic limestone - calcium carbonate in the shells of marine organisms - is the largest and most stable reservoir of carbon in the Earth’s crust. Most efforts to capture carbon through biological processes focus on forests, but our research suggests shellfish aquaculture provides a much longer-term sink, with high per-unit-area values. Hard clams, Mercenaria mercenaria, are commercially cultivated in Florida, USA, in high-density coastal lease areas. The shells weigh about 15-20 g per marketed clam, of which 12% is mineralized carbon. In addition to these shells, there are discarded clams and associated shellfouling organisms. We quantified all shell over 5 mm harvested by clam farmers near Cedar Key, Florida, including shell of associated taxa collected with the culture material (mesh bags). About 91% of the shell material was Mercenaria and most of the remainder was composed of oysters (Crassostrea virginica and Ostrea edulis). Over 37 other shellfouled taxa collectively comprised less than 1% of the total shell mass. Calcium carbonate content of major taxa was verified by coulometry and CNHS analysis. Each harvested market-size clam represented...
Mangroves are highly productive ecosystems that provide a variety of ecosystem services, including soft coastal protection. However, it is estimated that one quarter of the original mangrove cover has been lost worldwide due to human activities (World Atlas of Mangroves 2010). A quantitative understanding of the underlying principles controlling mangrove seedling establishment is needed to explain mangrove dynamics and improve restoration efforts. With an array of laboratory and field experiments we elucidate the abiotic processes that limit colonization of tidal flats by South East Asian mangrove pioneer species. We will demonstrate quantitatively how: 1) early anchorage of mangrove propagules is depending on windows of opportunity with low disturbance by hydrodynamics; 2) further seedling establishment and stability is limited by mixing and erosion of the upper sediment layer; and 3) sediment dynamics vary in magnitude from the mudflat to the forest. Present findings explain how the physical state of a tidal flat, characterized by hydrodynamic forcing and sediment movement, determines whether an area can be colonized or not. This fundamental understanding offers opportunities for innovative mangrove restoration approaches.

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ZOOPLANKTON RESPONSE TO HYPOXIA IN THE CHESAPEAKE BAY

Hyponxia is a common occurrence in fresh and salt water worldwide and can have negative effects on local fish and zooplankton including in the Chesapeake Bay. Copepods, specifically Acartia tonsa, are the most abundant type of zoolankton in the mesohaline reaches of the Bay. They occupy the base of the food web in many aquatic systems, including in Chesapeake Bay, and play a large role in transferring energy and material to higher trophic levels. We compared copepod behavior and fitness at both a hypoxic and anoxic site over three seasons, spring, summer and fall. It is hypothesized that low oxygen water will reduce the fitness of copepods and alter the migration behavior. To test this hypothesis, we observed copepod behavior and fitness using nets and traps, and we focused on migration patterns, population dynamics and RNA/DNA ratios.

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CHESAPEAKE BAY PROGRAM PHASE 5.3.2 WATERSHED MODELING APPLICATION

An HSIP-based watershed model has been used to simulate nutrient and sediment loading to the Chesapeake Bay for more than two decades. Over time, the Chesapeake Bay Watershed Model has increased in complexity commensurate with the management challenges in Chesapeake Bay restoration. In response, the Chesapeake Bay Program developed a software solution that builds upon the existing HSIP model structure. The software system, consisting of pre-processors, an external transfer module, and post-processors, was designed to conveniently generate and update parameter files essential to the operation of a complex watershed modeling system and to implement land use and non-point source management changes on any timescale. The Phase 5.3.2 software has been applied at the Chesapeake Bay Program to model management scenarios and their corresponding effects on loading of nitrogen, phosphorus, and sediment to the estuary. The Phase 5.3.2 Watershed Model, data, and analysis tools are developed using a community modeling framework. The source code, data libraries, and model documentation are provided through the Chesapeake Community Modeling Program for the user community.

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ASSUMPTIONS, METHODS OF EXTRACTING AND APPLICATION OF JUVENILE RED SNAPPER OTOLITH CHEMICAL SIGNATURES IN THE NORTHERN GULF OF MEXICO

Otolith chemical signatures provide powerful natural tags of fish populations and have been employed to estimate the contribution of different nursery areas to adult populations. Red Snapper, Lutjanus campechanus, is a long-lived, demersal reef fish that supports one of the most economically important reef fisheries in the northern Gulf of Mexico. Understanding which nursery areas provide recruitment to the fishery is critical for fisheries management. First, experiments were conducted to test whether coring and pulverizing juvenile red snapper otoliths affected their chemical signatures. Coring had a significant effect on elemental signatures (Hotelling’s Paired T2, p<0.015). This difference was associated with a systematic difference of slightly higher ratios in cored versus whole otoliths; however, no significant difference existed when residuals were tested. Coring had a significant effect on stable isotope signatures (Hotelling’s Paired T2, p<0.007). These differences were associated with a systematic difference of slightly higher δ13C and δ18O values in whole right versus cored left otoliths. Analysis of residuals revealed no difference when analysis was conducted on residuals instead of raw data. Second, a method to remove cores of adult otoliths was designed to allow cores to be removed as a single piece, which permitted each core to be decontaminated prior to preparing the core for elemental and stable isotope analyses. Lastly, tests were conducted to compare interspecific and regional variation between two congeners, red snapper and lane snapper (Lutjanus synagris), to determine if lane snapper otolith chemical signatures could be used as a proxy for red snapper signatures. Signatures were significantly different among regions (MANOVA, p<0.001) and between species nested within regions (MANOVA, p<0.001), suggesting that lane snapper chemical signatures do not serve as an accurate proxy for red snapper signatures.

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WASTEWATER TREATMENT PLANTS AND EARTHQUAKES: WHAT ARE THE ‘BLOOMING’ SEAWEEDS TRYING TO TELL US?

Historically, massive Ulva and Gracilaria blooms in the eutrophic Avon-Heathcote Estuary of Christchurch, New Zealand have significantly affected both the estuary’s aesthetic value and its ecosystem function. With the diversion of Christchurch city’s wastewater discharge away from the estuary in March 2010 it was expected there would be close to a 10-fold reduction in nitrogen(N)-loading, which in turn promised a reduction in algal biomass. A
three year partnership study between NIWA and University of Canterbury examined, amongst other ecosystem components, macroalgae biochemical indicators of seawater N-loading. Here we present results of the changes that have occurred over the last two years in Ulva (and Gracilaria) biochemical N-indices which include: chlorophyll, free amino acids, tissue-N, tissue-δ15N isotope and growth. We report a significant reduction in Ulva N-indices during the 8 months following the cessation of the treated sewage discharge to the estuary. Over this period total Ulva tissue-N showed a 30% reduction while tissue chlorophyll showed a 50% reduction. Although less dramatic the same decreasing trends were seen in Gracilaria tissue N-indices. However, a series of earthquakes beginning in September 2010 caused substantial leakage of untreated effluent into the estuary via broken sewerage pipes. The impact of the Christchurch earthquakes directly resulted in increases in in-seawater nutrients which in turn lead to increases in Ulva N-indices, sometimes approaching pre-diversion levels. In addition, qualitative shifts in Ulva tissue N-isotopes (δ15N) reflected complex shifts in nitrogen source pools in the estuary occurring over the course of this study. We discuss the consequences of these events on macroalgal growth and productivity in the estuary. In conclusion these results endorse the use of Ulva as a powerful indicator of changes in both amount and source of nitrogen that can affect estuaries and other sheltered waters.

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ECOSYSTEM SERVICES ON A SANDY BARRIER ISLAND: A GEOGRAPHIC REPRESENTATION

Sandy barrier islands, as their name implies, act as a barrier between oceanic and bay waters. Their unique geologic and hydrologic settings offer the conditions for numerous ecosystems to thrive and develop, such as seagrasses, marshes, flats, dunes, and beaches. Although barrier-island ecosystems provide many services that support human activities and well-being, only a handful of ecosystem services are usually studied, valued, and therefore widely recognized. A schematic of the different ecosystem services on Mustang and North Padre Islands, Texas along with their location and spatial extent has proven to be a useful reference in current ecosystem services mapping and valuation efforts. This schematic is the result of an in-depth review of scientific literature to identify and summarize ecosystem services information available for sandy barrier islands combined with existing geomorphic and habitat spatial data. The goals of this graphical representation and inventory of ecosystem services are (1) to serve as a reference for natural resource inventories and future scientific studies, (2) to bring awareness of the existence of different ecosystem services into planning practices, and (3) to serve as an educational tool for the general public.

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TIDAL AND LATERAL ASYMMETRY IN STRATIFICATION IN A COASTAL PLAIN ESTUARY

Recent studies have shown that spatial and temporal asymmetries in turbulent mixing may influence estuarine exchange by introducing residual currents. The objectives of this study are to investigate the influence of temporal and spatial asymmetries in vertical mixing on estuarine exchange flow, and to compare observations to numerical and analytical results. Observations were obtained at the transection between the James River and Chesapeake Bay. Residuals induced by asymmetric mixing were found to be of the same order of magnitude as the density-driven flow. Residual profiles showed either two or three layers in a channel and two layers over shoals. Tidal straining (i.e. stratified ebb and well-mixed flood) enhanced gravitational circulation, whereas reversed straining opposed it. The contribution of residuals induced by asymmetric mixing increased as stratification increased. Inconsistencies between observations and models are attributed to model assumptions (e.g. no Coriolis forcing, no topographic features) and a complicated nature of stratification.

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SUCCESSFUL DEVELOPMENT/APPLICATION OF NUTRIENT/SEDIMENT ENRICHMENT CRITERIA DRIVING CHESAPEAKE BAY RESTORATION - 25 YEARS OF EXPERIENCES

With roots as far back as 1985, the Chesapeake Bay Program partners - DE, DC, MD, NY, PA, VA, WV, EPA, and other federal and local agencies - have a multi-decadal history of developing and then adopting a suite of nutrient/sediment enrichment water quality criteria into the four tidal water jurisdictions’ water quality standards regulations. These partner-approved water quality criteria, published by EPA in 2003, started out as a set of “habitat changes” in the late 1980s. Through the 1990s, additional research and an ever increasing base of monitoring data supported development of a series of technical syntheses of the latest scientific understanding by the scientific and management communities. Specific commitments within the Chesapeake 2000 Agreement laid out a roadmap for the partnership to reach agreement on and support adoption of a set of Chesapeake Bay water quality standards that all seven watershed jurisdictions could agree to and fully support. The resultant Delaware, District of Columbia, Maryland, and Virginia Chesapeake Bay water quality standards regulations, adopted in 2004-2005, were entirely consistent across a common set of five tidal water designated uses. All four jurisdictions adopted consistent use-specific protective criteria, criteria assessment procedures, and listing/delisting decision making protocols. Since their initial publication in 2003, EPA and its jurisdictional partners has published a series of addenda to the Chesapeake Bay criteria and designated uses, which were then adopted by the four jurisdictions’ into their water quality standards regulations. These Chesapeake Bay water quality standards formed the basis for the December 2010 Chesapeake Bay TMDL - a basinwide pollution diet being undertaken collectively by the 17 million watershed residents.

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PUTTING MILLIONS OF WATERSHED RESIDENTS ON REGULATORY POLLUTION DIETS: FROM CHESAPEAKE BAY TO THE GREAT LAKES TO LONG ISLAND SOUND

Against the backdrop of over 45,000 TMDLs approved by EPA nationwide over the past two decades, the six watershed states, the District of Columbia, and EPA have developed a historic and comprehensive “pollution diet” with rigorous accountability measures to mitigate sweeping actions to restore clean water in the Chesapeake Bay and the region’s streams, creeks, and rivers. Despite extensive restoration efforts and significant pollution reductions during the past 25 years, the TMDL was promptly by insufficient progress and continued poor water quality in Chesapeake Bay and its tidal tributaries. The Chesapeake Bay TMDL was designed to ensure that all pollution control measures needed to fully restore the Bay and its tidal rivers are in place by 2025, with at least 60 percent of the actions completed by 2017. The TMDL assigns responsibilities for reducing and then capping sources through waste load and load allocations to regulated and non-regulated sources, respectively. Separate nitrogen, phosphorus, and sediment allocations were made for each of 92 watershed draining directly into each tidal Bay segment, further subdivided by state jurisdiction. The Bay TMDL is supported by rigorous accountability measures to ensure cleanup commitments are met, including short-and long-term benchmarks, a tracking and accounting system for jurisdiction activities, and federal contingency actions that can be employed if necessary to spur progress. Similar regulatory efforts in the Great Lakes and Long Island Sound, initiated well before publication of the Chesapeake Bay TMDL will be compared and contrasted.

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ADAPTIVE MANAGEMENT IN THE LOUISIANA COASTAL AREA

Adaptive management was authorized for the Louisiana Coastal Area (LCA) program under Title VII of the Water Resource Development Act (WRDA) 2007. Additionally, Section 2039 requires ecosystem projects to be monitored for up to 10 years, or until success is achieved. There is, however, minimal guidance on how the adaptive management plans should be written and implemented through the Corps’ planning process. The LCA Adaptive Management Team is comprised of members from the U.S. Army Corps of Engineers (USACE) New Orleans, Wilmington, and St. Louis Districts, as well as the USACE LCA Science and Technology Office, USACE Environmental Research and Development Center (ERDC), Division of the Louisiana Office of Coastal Protection and Restoration (OCPR) Louisiana Applied Coastal Engineering and Science (LACES), and U.S. Geological Survey National Wetland Research Center. This multidisciplinary team has been charged with writing, modifying, and implementing the adaptive management plans, through the Corps’ planning process. This presentation will provide an overview of the process, demonstrate elements, and phases of adaptive management for the LCA program, as well as a description of the monitoring program, and criteria for project success developed by the team. There will also be a discussion of lessons learned and future steps for the LCA program adaptive management.
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MICROPHYTOBENTHOS AND THEIR POTENTIAL ROLE IN THE NORTHERN GULF OF MEXICO HYPOXIC ZONE

The presence of microphytobenthos on the inner continental shelf of the northern Gulf of Mexico may influence the benthic ecology and oxygen dynamics of the hypoxic area. To determine if microphytobenthos or settled phytoplankton were present on the sediment surface, we sampled three stations (14, 20 and 23 m depths) – 100 km west of the Mississippi River over three annual hypoxia cycles (2006 – 2008), and at 11 stations along a 14 - 20 m contour on the shelf in late-July 2006, 2007 and 2008. Microscopy and high-performance liquid chromatography (HPLC) estimated the presence, potential biomass and composition of phytoplankton in surface and bottom waters, and the microphytobenthos in sediments. The sediment community (cells > 3 μm) differed from those in the water column and were frequently composed of benthic cells (58-88% seasonally and 1-99% mid-summer). Microphytobenthos were predominantly diatoms (Amphora, Nitzschia, Navicula, Pleurosigma and Bacillaria) and cyanobacteria (filamentous and colonial). Pelagic and tychopelagic phytoplankton made up the remainder of the sediment community. Sediment chlorophyll a concentrations were commonly < 2.0 μg g dry sed-1 and biotic variables were correlated with seafloor PAR. Perhaps where microphytobenthos density and biomass are high, they may provide a basal carbon resource to the benthos, regulate benthic nutrient fluxes, and influence benthic oxygen dynamics.

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ENVIROMENTORS: A SUCCESSFUL MULTIDISCIPLINARY ENVIRONMENTAL SCIENCE MENTORING PROGRAM

EnvironMentors is an environmental science-based college-access program sponsored by the National Council for Science and the Environment for at-risk and under-represented high school students. The program pairs each student with a mentor(s) (e.g., graduate student, professor, science professional) and throughout the school year the pairs meets once a week to develop and conduct a science fair research project. The LSU chapter is housed in the School of the Coast and Environment and concluded a successful inaugural year. Paramount to the success of the LSU chapter is the partnerships with Louisiana Sea Grant and LSU GearUp, a program of the U.S. Department of Education. GearUp helps to identify students who are well suited for the EnvironMentors program, provides weekly in-school support, and provides the students with transportation to and from our weekly meetings. Providing transportation and rewarding students for consistent attendance and for completing projects helped to retain students in the program throughout the school year. This joint venture between scientists and educators allows our program to provide high school students with hands-on science experience, a variety of environmental education field trips, and college campus tours. The students gained valuable opportunities over the course of the year including computer skills (e.g. word processing, graph/table making, professional poster development), scholarship and financial aid information for college, research methods for water quality monitoring, research methods needed for their science fair projects, and awareness of the environmental and environmental issues. Mentors also benefited from the mentoring relationship by practicing their teaching and mentoring skills and having a broader impact to the community. The collaboration among scientists, educators, and the local school has resulted in a successful education and outreach program that benefits all who participate.

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MESOCOSM EXPERIMENTS USED TO EVALUATE THE MORPHOLOGICAL RESPONSE OF GENETICALLY DISTINCT EELGRASS (ZOSTERA MARINA) POPULATIONS TO REDUCED LIGHT AND INCREASED SEDIMENT ORGANIC CONTENT LEVEL

The role genetic diversity plays in the expression of various morphological characteristics under changing environmental conditions is poorly understood and important to consider for seagrass conservation, management and restoration efforts. In this study, neutral genetic markers were used to assess genetic diversity and relatedness of 40 eelgrasses (Zostera marina) beds along the coast of southern New England and New York. Of the 40 beds surveyed, we selected ten distinct populations, with varying levels of genetic and genotypic diversity, for mesocosm experiments where light availability and sediment organic matter content were manipulated. Ramets from each population were transplanted into twelve 1 m³ flow-through seawater outdoor mesocosm common gardens and submitted to nutrient (100 and 50% ambient) and two sediment organic content (2 and 8%) treatments simultaneously in a full factorial experiment. Measurements of shoot morphology, including leaf length, number of leaves, leaf area, and growth rate for the different eelgrass populations were taken for three months following the start of the treatments in June. Shoot morphology was altered by reduced light while growth was inhibited in the organic enriched sediments due to elevated sulfide production. The combined effects of reduced light and increased sediment organic level further exacerbated the stress response. The treatment responses differed among eelgrass populations, but followed the same general trend. The variation in morphological responses to stress treatments among eelgrass populations may be useful for identifying populations which are more resilient to a changing environment and thus potentially more suitable as donor stock for restoration projects.

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LIVING ON THE LIDGE: ASSESSMENT OF CORAL STRESSORS ON ST. LUCIE REEF, FLORIDA

Numerous stressors and their synergistic effects on coral reef communities have been identified on reefs worldwide using various techniques to quantify organismal and community responses. Understanding the effects of stressors is critical to the protection and restoration of these declining habitats. St. Lucie Reef in east-central Florida is strongly influenced by freshwater discharges through the St. Lucie Inlet from the St. Lucie River and its expanded watershed, including Lake Okeechobee. Blackwater events occur regularly, especially in the wet season, as the prevailing long-shore current moves inlet discharge onto the reef, persisting for days, weeks, or months. The objectives of this study were to assess and define the effects of blackwater events on coral health. Corals (Montastrea cavernosa and Diploria clinovia) were sampled at three sites south of the inlet during mid-summer and fall, 2010. Tissues were assessed using two profiling technologies for quantifying sub-lthal coral health: expression analyses with a custom coral stress-gene microarray and length-heterogeneity PCR for bacterial communities. M. cavernosa showed significant differences in gene expression for 31 of 150 genes, mainly between corals from the different sites and secondarily between collection periods. Genes showing differential expression are involved in the regulation of cell death, xenobiotic metabolism, proteolysis and immune response. Vitellogenin, a gene involved in gametogenesis, showed significantly lower expression in coral samples from the central site in August. In situ light sensors revealed consistent latitudinal trends in water clarity dependent upon flow and tide, with Kd values ranging from 0.15±0.06. The results of this project will determine the relative health of corals on St. Lucie Reef versus those studied elsewhere in the Caribbean and will be used for adaptive management recommendations for ongoing and proposed regional restoration efforts.

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REMOtELY SENSED ANALYSIS OF MARSH COLLAPSE THRESHOLDS IN COASTAL LOUISIANA

Modeling efforts for the Louisiana State 2012 Master Plan required the projection of coastal landscape conditions under variable relative sea level rise (RSLR) scenarios. Important uncertainties exist concerning the conditions under which marsh is lost as a result of parameters related to RSLR. Much of the available information on relationships between vegetation productivity and inundation in coastal Louisiana is limited to particular species such as Spartina alterniflora, but the response of other vegetation types to changes in inundation are less well-understood. A great deal of remotely sensed data exists which could prove helpful in determining conditions at which various marsh types cease to occur. The relationships presented here have been informed by various sources of remotely sensed and geospatial data including Normalized Difference Vegetation Indices (NDVI) for vegetation productivity, and elevation and mean water level data to determine depth of inundation. Relationships between depth of inundation and productivity were evaluated for each of the common marsh types in coastal Louisiana. Trends in these relationships were extended toward intercepts at 1.5 and 2 standard deviations below the mean in the productivity data. The presence of these threshold values were used to determine uncertainty ranges for each marsh type, within which marsh collapse is probable. Uncertainty ranges with regard to marsh collapse, as well as other parameters associated with RSLR, were then used to model multiple wetland change scenarios over a 50-year time period.
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THE EFFECTS OF OYSTER HARVEST ON THE COMMUNITY STRUCTURE AND TROPHODYNAMICS OF RESIDENT OYSTER REEF COMMUNITIES IN COASTAL LOUISIANA

Oyster reefs provide diverse ecological services in estuaries, including the creation of refuge and foraging habitat for numerous organisms. Oyster harvest, along with major storms and changing salinity regimes, provides substantial disturbance to oyster reef habitat in the northern Gulf of Mexico. How oyster dredging alters reef substrate and affects resident fauna has not been thoroughly examined on the productive sub-tidal oyster reefs of coastal Louisiana. Structural reef complexity and resident nekton community structure were compared at unharvested and harvested reefs during the spring, summer, and fall of 2010. Harvested reefs had higher amounts of loose shell, mixed shell/mud substrate, and elevated chlorophyll-a levels, while unharvested reefs had higher amounts of oyster clusters, solid reef substrate and more market-size oysters. Total nekton density did not differ with harvest status and dominant species were similar (Eurypanopeus depressus, Palaeomonetes spp., and Gobiosoma bosc), although G. bosc density was higher at harvested sites and Palaeomonetes spp. density was higher at unharvested sites. Greater species diversity was found at harvested sites and community assemblage differences were accounted for by dominant species. The primary habitat variables found to influence assemblage included the amount of mixed shell/mud substrate and number of market-size oysters, possibly reflecting differences in habitat heterogeneity and/or forage resources. Stable isotope values (δ13C and δ15N) of dominant species and basal food sources were used to compare food web characteristics between sites. Trophic levels of dominant species were elevated at harvested reefs. In areas of oyster harvest, communities were more dependent on marsh than phytoplankton as a basal food source. Increased basal phytoplankton contribution and lower chlorophyll-a levels at harvested sites provide evidence of the benthic-pelagic coupling services that mature oyster populations provide.

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EFFECTS OF GEOMORPHOLOGY ON COASTAL MARSH SUBSIDENCE IN CHESAPEAKE BAY

Coastal marshes of Chesapeake Bay are threatened by factors associated with sea-level rise including saltwater intrusion and sulfate intrusion. Marshes of differing geomorphological type, and thus differing substrate conditions, may have differential responses to changes in salinity, flooding and sulfates. Estuarine meander marshes have deep, organic-rich, Holocene deposits and may be affected more dramatically by an increase in decomposition, as is hypothesized with sea-level rise. Submerged upland marshes, however, are underlain by mineral sediments that were more recently upland soils, and have thinner layers of organic-rich peat and silt deposited on top of submerged upland soils. Increases in decomposition rates over the last century, resultant from sea-level rise, may exert greater influences on estuarine meander marshes, causing greater losses in surface elevation, and increasing their vulnerability to rising sea levels. In this study, coastal marshes of differing geomorphological type were compared according to cores taken to depths of underlying sand, and by rates of elevation change over a four-year period. Preliminary results indicate that estuarine meander marshes have greater rates of subsidence and much deeper profiles compared to submerged upland marshes.

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WATERSHED ANALYSIS OF PERMITTED COASTAL WETLAND IMPACTS AND MITIGATION METHODS WITHIN THE CHINEP

This study identifies the regional impacts on coastal wetlands of the current ERP process and program of compensatory wetland mitigation and an evaluation of the performance of three wetland functional assessment methods, WRAP, UMAM, and HGM, in the coastal wetlands of the Charlotte Harbor National Estuary Program and the fate of some long-term on-site wetland functional assessment methods, WRAP, UMAM, and HGM, in the coastal wetlands program of compensatory wetland mitigation and an evaluation of the performance of three wetland functional assessment tools. There is also the process of relocating wetland functions out of impacted wetlands toward the watersheds able to provide approved off-site mitigation. While the functional assessment evaluation shows a mathematical balance sheet for the total service area that is equal to or better than parity for a project that utilizes a mitigation bank, with rare exception, there is a real loss of wetland acres and function in the donor watershed and an increase in function, but not necessarily new acres of wetlands created in the receiving watershed.

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CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION OPPORTUNITIES FOR SALT MARSH TYPES IN SOUTHWEST FLORIDA

The salt marsh community of Southwest Florida is perhaps one of the most unique and rare salt marsh systems in the United States. The mild subtropical climate of Florida supports a combination of temperate salt marshes Vegetational and tropical mangroves that intermixture to form an important transitional ecotone between land and sea. The salt marsh offers numerous ecosystem services including recreational, commercial, and aesthetic values to man. It provides the foundation of life to a variety of resident and transient organisms, especially the six federally listed and 23 state-listed animal species found there. Almost 66 percent of the remaining salt marsh habitat in Southwest Florida is protected through public ownership or regulatory restrictions. This habitat, however, continues to be lost due to human-induced, permitted, impacts such as dredge and fill operations, alterations of hydrology, and pollution. The Southwest Florida Regional Planning Council (SWFRPC) and the Charlotte Harbor National Estuary Program (CHINEP) will inventory and map the physical extent of six types of salt marsh present within the CHINEP Study Area. Researchers will then identify significant potential effects on these salt marsh ecosystems from anticipated climate change. Opportunities for avoidance, minimization, mitigation and adaptation that could be implemented will be identified. An interactive GIS mapping product depicting the project outputs will be uploaded to the CHINEP website for use by researchers and the public. Natural functions that provide ecosystem resiliency will be identified along with policy, land stewardship and structural options. The presentation will give an update on the progress of the project to date, including documentation of the plant and animal species encountered (with photographs), and a comparison of current to historic aerial photographs showing the changes in extent and topographical range of selected salt marshes between the 1950s and today.

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AN INTEGRATED APPROACH TO CLIMATE CHANGE VULNERABILITY, RESILIENCY AND ADAPTATION

The Charlotte Harbor National Estuary Program (CHINEP) adopted a climate change priority action within its 2008 Comprehensive Conservation and Management Plan (CCMP) update. The plan outlined a framework to CHINEP to “build capacity for communities and their local leadership to mitigate and adapt to the effects of climate change through joint efforts.” The Southwest Florida Regional Planning Council (SWFRPC) and CHINEP jointly developed an integrated approach to climate change assessment and planning that has allowed a progressive expansion of scope and detail, building on past work with each step. The iterative process has developed frameworks which are being replicated in other locations. The integrated approach has yielded: 1) A 2005 Assessment of the Southwest
Florida Comprehensive Watershed Plan (authorized under the Water Resources Development Act 2000) from resiliency and sea level rise perspectives; 2) A Southwest Florida Regional Climate Change Vulnerability Assessment; 3) A citizen and decision-maker friendly Charlotte Harbor Regional Climate Change Vulnerability Assessment; 4) The City of Punta Gorda Climate Change Adaptation Plan; 5) Model comprehensive plan and ordinance language to address sea level rise in Punta Gorda; 6) Draft Comprehensive Plan amendments under “Notice of Public Hearing” by the City of Punta Gorda; 7) The Lee County Climate Change Resilience Plan; 8) Climate Change Environmental Indicators; 9) Climate Change Conceptual Ecological Model (CEM) and 10) Salt Marsh Type and Extent Resilience and Adaptation. The key component to the process was development of a comprehensive vulnerability assessment which formed a foundation for the subsequent work. The final products can be found at: www.chenp.org/projects/climate/CRE.htm; www.swfpc.org/climate_change.html; www.ci-punta-gorda.fl.us/depts/growthmgmt/compplan.html.

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MODELING RESTORATION SCENARIOS IN A CALIFORNIA BAR-BUILT ESTUARY

Bar-built estuaries in Mediterranean climates often experience inlet closure during low-flow events. This results when waves fill the inlet channel with sediment, which temporarily transforms the estuary into a sharply salt-stratified lagoon and forces river inflows to flood local low-lying areas. In California, long-term changes in watershed and beach management have altered the frequency and timing of these natural recurring events. Often, the legacy of human intervention is so extensive that little information exists about these systems in their undisturbed state. This has complicated current management efforts which must balance flood prevention and water quality concerns with the task of restoring populations of endangered salmonid species, which use the closed lagoons as rearing grounds. This is especially true of the Russian River estuary, a prototypical bar-built estuary in northern California. Presently, the river is manually breached to shorten closure events, while existing data suggest that before human intervention the site may have closed for lengthy periods of time during dry periods. In the present study we use a numerical model to explore a suite of hypothetical management scenarios which balance flooding risks and salmonid habitat requirements. We simulate a three-month dry season period in which the inlet is consistently closed or, alternatively, has a perched one-way overflow channel allowing flow over the beach - a scenario that has also been observed in similar systems. We also focus on changes in the estuary stratification in response to barrier seepage, internal seiche dynamics and inflows over the three-month period. Finally, we compare our results with observations of long-term closure events at this and two proximate northern California estuaries.

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EFFECTS OF SALT MARSH GEOMORPHIC STRUCTURE ON SEDIMENT ACCRETION

Field observations and numerical studies have shown that vegetation density, elevation and distance from the channel are major controls on salt marsh sediment accretion. However, absent or ignored from these analyses are the effects of salt marsh structure. In this study, we evaluate the geomorphic structure of a 0.5 km2 South Carolina salt marsh island, and contrast those properties with observed accretion rates determined from 43 sediment traps collected annually over three years, and with historic aerial photography. There were significant differences in accretion rate at sites within the narrow range of marsh platform elevation, but at geomorphically distinct locations. In particular, variations in intertidal creek mouth elevation, longitudinal creek profile characteristics, creek hypsometry, and headwater area show a strong association with sediment accumulation. Overall, the intertidal landscape structure accounts for 28% of the total spatial variability in salt marsh sediment accretion.

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SCALE EFFECTS IN THE USE OF CONTINUOUS RECORDING DATA WHEN COMPARED TO MONTHLY SYNOPTIC SAMPLING IN SALINITY DATA COLLECTION IN BISCAYNE BAY, FLORIDA

Biscayne National Park has been collecting continuous conductivity, temperature, and depth data in fifteen minute intervals for the last seven years at 34 sites. The Miami-Dade County Department of Environmental Resources Management (MDDERM) has been collecting the same data along with additional water quality parameters monthly for more than thirty years. When these data sets are compared it is possible to determine the relative effects of aggregation of data on the resulting statistics. As data is aggregated to longer periods, resolution and variability are lost. Variability is important to biota both in a positive and negative way. In the current Biscayne Bay restoration it is some of these isolated or unusual events that are targeted to be increased as an ecological benefit. However, when data is aggregated to longer intervals, these unusual events become difficult to see or are lost in the analysis. Using the intensive National Park Service data set it is clear that when salinity is variable this variability is generally not captured in the longer term monthly synoptic data. In reviewing the highly variable salinity data of Biscayne Bay, salinity changes that happen over a period of hours or days are lost in the longer term monthly data set. In creating salinity simulations spatially it is important to consider the different types of data being used and it is necessary to use the data on the appropriate scale. It would be inappropriate to use monthly data to evaluate daily or shorter term processes. It would also be inappropriate to use the high intensity shorter term data to evaluate long term climatic changes that operate on a much larger scale. Often data is collected on one scale and then used to make decisions on an inappropriate scale. We review these two time series data sets and describe their relative strengths and weaknesses as well as describe the most appropriate uses of these two different types of data.

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SETTING ECOLOGICAL RESTORATION TARGETS: A PROPOSED METHODOLOGY FOR BISCAYNE BAY, FLORIDA

Biscayne Bay is a subtropical lagoon, which was historically an estuarine system. Currently, it is characterized by marine conditions and a variable delivery of freshwater dependent on human needs more than on ecosystem requirements. It is one of the downstream receiving estuaries of the Comprehensive Everglades Restoration Plan (CERP) Ecosystem and is a component of the CERP planning process. Various performance measures have been developed under CERP to evaluate model performance and compare different restoration scenarios. Performance measures have been developed to relate physical parameters such as salinity to historical conditions using historical biotic communities. Performance measures are divided between those needed to compare model driven scenario testing among alternatives and the need to predict and verify downstream response of the ecosystem. Successful restoration targets will make a connection between hydrologic models, historical or target conditions, and current conditions. It is necessary to develop a quantifiable relationship between the physical variable being controlled, and the desired ecosystem change into the future. We suggest the use of three levels of evaluation tools for different levels of knowledge. First, presence-absence sampling as a means of identifying the extreme ecosystem ends, such as extirpation or other unacceptable conditions. Second, develop a predicted extent of the organism based on data from the physical variable of interest, under the current operation conditions. Finally, prediction of future extent of habitat based on the ecological needs of the organism of interest related to the physical variable. To accommodate the lack of data for any one species, a combination of organisms can be used to calculate different steps for these evaluations. These steps can be applied to create a more quantifiable picture of restoration success.

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NITROGEN CYCLING IN COASTAL LAGOONS AND ESTUARIES IN MEXICO: BIOGEOCHEMICAL PROCESSES AND VULNERABILITY TO GLOBAL CHANGE

Nitrogen (N) acts as an essential nutrient in coastal and estuarine ecosystems, where it is rapidly cycled by microorganisms and converted to gaseous forms. Much of what we know about these N transformations is drawn from typical temperate estuaries, but subtropical lagoons may behave differently; understanding this behavior is critical because human activity has doubled the amount of N reaching the coast, leading to coastal eutrophication, harmful algal blooms, and hypoxia. I examined N transformations in Bahía del Tóbari, a subtropical lagoon in Sonora, Mexico, that receives pulses of N in agricultural runoff. N is rapidly processed by diverse microbial communities, and a relatively low proportion (~4%) of total N inputs are exported to the coast. However, the episodic nature of these losses has significant ecological consequences - including large phytoplankton blooms in coastal waters. My results also indicate that microbial N cycling processes are sensitive to temperature change and ocean acidification, with substantial implications for future coastal ocean biogeochemistry.
storm surges and developing an interactive online visualization tool to the existing sea level rise modeling work for the Florida Keys. Draft outputs will be presented for feedback. 

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RESTORING BIVALVES TO INCREASE NATURAL CAPITAl: A WATERSHED-WIDE APPROACH

Bivalves provide valuable ecosystem services in both fresh and estuarine waters. Thus, restoring them will increase natural capital—the natural resources (such as trees or oceans) that provide ecosystem services. Many of the studies on bivalves as natural capital have focused on a single species (such as Eastern oysters), a small group of abundant species, or a single tidal estuary or non tidal river. We are looking for the best ways to increase natural capital by restoring bivalves across an entire watershed, specifically in the Chesapeake Bay and Delaware Bay watersheds. The Chesapeake Bay portion of the project is an action for NOAA and US FWS in Executive Order 13508, “Strategy for Protecting and Restoring the Chesapeake Bay,” while the Delaware Bay portion is part of the mission of the Partnership for the Delaware Estuary, a National Estuary Program. The approach we are taking includes (1) reviewing the literature on the ability of different species of freshwater and estuarine bivalves to enhance water quality and provide other services, to identify likely candidate bivalve species, (2) working with ecosystem modelers to use data on water quality conditions, hydrology, bivalve filtration ability and bivalve restoration costs in models to predict the most cost-effective bivalve restoration strategies for filtration benefits, (3) combining those filtration-based model scenarios with estimates of other ecosystem services provided by bivalves (such as increased habitat complexity, changes in sediment biogeochemistry, decreased bed transport, and pathogen removal) to get a more complete estimate of ecosystem services from bivalve restoration, and (4) using the results of these efforts to design, get funding for, and carry out pilot bivalve restoration projects. Some efforts that are using this approach will be described.

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BENTHIC NUTRIENT FLUXES IN LITTLE LAGOON, ALABAMA

Spatial fluxes on benthic nutrient flux and denitrification rates were investigated in Little Lagoon Alabama and temperature and microphytobenthos (MPB) were hypothesized to regulate nitrate flux. Three sites in the lagoon were chosen to represent the end-points and middle gradients of salinity and nutrient content (East: 6°C -23.0, C:N 10.3; West: 6°C - 15.6, C:N 7.9; and Pass: 6°C -18.9, C:N 6.7). Porowater profiles exhibited a concentration decline with time and temperature from high values in summer (NO3-C: 207.49 ± 29.80; PO4-C: 0.71 ± 0.16 nmol cm-2 SE) to more moderate values in winter (NO3-C: 0.85 ± 0.24; NH4-N: 11.82 ± 4.04; PO4-C: 34.60 ± 6.38 nmol cm-2 SE) to more moderate values in winter (NO3-C: 0.85 ± 0.24; NH4-N: 11.82 ± 4.04; PO4-C: 34.60 ± 6.38 nmol cm-2 SE). There were both spatial and temporal gradients in the composition of the MPB. These were photosynthetically competent and irradiances at the sediment surface were sufficient to drive benthic productivity, hence nutrient demand. Dark-light sediment core incubations indicate that MPB can change the magnitude and direction of nitrogen (N) flux in the sediments and supply nutrients from the benthos to the water column. Hydrogen sulfide (HS-) was present in high concentrations (>1000 μM) in the top centimeters of sediment in the summer of 2010 but was undetectable at the Pass and East sites in January 2011 and had moderate concentrations at all sites in April 2011. The presence of HIS- in the sediments supports findings of low denitrification activity (3 to 12 μmol m⁻² h⁻¹) at the three sites and thus indicates the potential inhibition of macrophytobenthic and benthic denitrification by HIS during the summer months. Porowater nutrient profiles, benthic nutrient flux and denitrification activity in Little Lagoon seem to indicate the predominance of dissimilatory nitrate reduction to ammonium over removal of fixed nitrogen via denitrification and may lead to a positive feedback in the system, further enhancing episodic algal blooms in the Lagoon.

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INCREASED VARIABILITY OF MICROBIAL COMMUNITIES IN RESTORED SAL MARSHES NEARLY 30 YEARS AFTER TIDAL FLOW RESTORATION

We analyzed microbial community diversity from sites impounded for 40-50 years and subsequently restored and undisturbed salt marsh sites in southeastern Connecticut over one growing season. Community diversity was assessed by terminal restriction fragment length

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VISUALIZATION OF SEA LEVEL RISE AND STORM SURGE INTERACTIONS IN THE FLORIDA KEYS

In the next one to three centuries, sea level rise is likely to undo most, if not all, that has been done over the past century to protect the terrestrial plants, animals and natural communities of the Florida Keys. Negative impacts on the built environment and human communities are also likely to be serious and irreversible. The Nature Conservancy modeled sea level rise scenarios described in the scientific literature for Big Pine Key, the core habitat area of endangered Key deer and other vulnerable species, using high resolution digital elevation data. Future shoreline locations and distribution of major habitats of the island in the year 2100 were graphically depicted. Estimation of corresponding property value losses are diminished. In the best case scenario, 18 cm (7 in) of sea level rise, 1,840 acres (34%) of upland habitat moves upslope at the expense of upland habitat, and property values

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DISTINGUISHING NATURAL VARIABILITY FROM WATER MANAGEMENT EFFECTS IN ANALYSIS OF ECOLOGICAL DATA FOR EVERGLADES RESTORATION

Good environmental performance metrics provide a signal of change caused by human activities such as restoration projects and water management alterations, against a background of natural climatic and ecological variability. Characterizing a baseline condition for the Comprehensive Everglades Restoration Plan’s (CERP) ecological targets at the freshwater marsh-mangrove interface north of Florida Bay is especially challenging given the region’s hydrologic variability and ongoing water management modifications to the area. Currently, a key CERP project (C-111 Spreader Canal Western Features Project, C111SC) is attempting to restore natural sheet flow patterns (quantity and timing) in Taylor Slough and associated salinity patterns downstream in Florida Bay (magnitude and variability), with the expectation that this will yield ecosystem restoration. A fifteen year dataset describing upstream and downstream hydrologic parameters, density of aquatic vegetation, and wading bird prey-base fish community composition from the southern Everglades, including the C111SC domain, provides an opportunity to evaluate whether hydrological and ecological objectives of the project are realized. We will outline how these datasets will be evaluated via hypothesis-driven performance metrics across spatial and temporal gradients. Our method first addresses the need to distinguish the effect of variable rainfall patterns by defining hydrologic relationships between upstream – downstream drivers for a given baseline period. We then use modeling procedures to translate these hydrologic and habitat drivers into predictions for prey fish community metrics for a pre and post-project assessment period.

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DECADAL CHANGES IN BENTHIC COMMUNITY MEASURES IN NEW YORK HARBOR

Monitoring in New York Harbor, NY, as part of the Regional Environmental Monitoring and Assessment Program has spanned a decade, and includes habitat and water quality measures and sediment contaminant levels from four sub-basins (Upper NY Harbor, Lower NY Harbor, Newark Bay, and Jamaica Bay). Previous investigations have evaluated the status of the benthic community in New York Harbor after five years, and now, with the final year of sampling, we examine changes in that community over 10 years. The U.S. E.P.A. Environmental Monitoring and Assessment Program’s benthic index for the Virginian Province and the New York Harbor benthic index of biotic integrity were applied to benthic abundance and water quality data. Our goal is to analyze differences in the benthic community by station and by sub-basin, and compare those observations with sediment and water quality analyses to identify trends in condition over the 10-year monitoring period.

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INCREASED VARIABILITY OF MICROBIAL COMMUNITIES IN RESTORED SAL MARSHES NEARLY 30 YEARS AFTER TIDAL FLOW RESTORATION

We analyzed microbial community diversity from sites impounded for 40-50 years and subsequently restored and undisturbed salt marsh sites in southeastern Connecticut over one growing season. Community diversity was assessed by terminal restriction fragment length
polymorphism (TRFLP) and sequence analysis of 16S ribosomal RNA (rRNA) genes. Communities were diverse, representing 18 different bacterial divisions, with Gammaproteobacteria and Bacteroidetes comprising the majority of sequences. Multivariate analysis of the TRFLP data suggested significant site, sample date and disturbance effects, but the exact causes of these effects are not clear. Sites that had been impounded and subsequently restored showed greater variability of bacterial communities compared to undisturbed sites and variability in diversity was greatest at sites more recently restored. Bacterial abundance, measured by real-time PCR of Bacterial 16S rRNA genes, was not significantly different between restored and undisturbed sites. Community differences were not correlated to differences in salinity, pH, water content, or nitrogen, but may be influenced more by the degree of tidal flooding and oxygen availability in addition to restoration status. In summary, our study suggests there may be long-lasting disturbance effects on the bacterial communities in restored salt marshes and raises questions about the resilience and ultimate recovery of the communities after chronic disturbance.

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ECOLOGICAL RISK ASSESSMENT FOR MARINE SPATIAL PLANNING

Coastal oceans provide a number of important benefits to people. Despite their importance, the ecosystem processes on which people rely for food, protection from storms, and recreation, and other services are poorly understood, scarcely monitored, and often only appreciated after they are lost. Multiple stressors including fishing and climate change threaten the ability of coastal oceans to provide valuable goods and services. As human activities continue to intensify in coastal areas, so does the need for quick, transparent and repeatable ways of assessing and communicating the risks posed by human activities. Recognizing and valuing human activities and their impacts on ecosystem services can enable diverse stakeholders to find common ground and facilitate decision-making that incorporates the true costs and benefits of natural resource management to the environment and society. Here we present a risk assessment model, part of a new decision support tool called InVEST (Integrated Valuation of Ecosystem Services and Trade-offs). The risk of human activities to the functioning of nearshore ecosystems is a function of the exposure to stressors and the consequence of exposure. Outputs from the model are useful for understanding the relative impact of human activities on ecosystems among alternative future scenarios, and for identifying which habitats are of high enough quality to provide the services people care about. The model will help to prioritize areas for conservation and restoration and inform the design and configuration of marine spatial plans. We will present results from the application of the model on the west coast of Vancouver Island, Canada.

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ECOSYSTEM AND NITROGEN DYNAMICS BEFORE, DURING, AND AFTER AN ANOXIC WATER VENTILATION

The Pettaquamscutt (Narrow River) Estuary is a 9km long estuary in southern Rhode Island. The Pettaquamscutt (Narrow River) Estuary is a 9km long estuary in southern Rhode Island.ANOXIC WATER VENTILATION ECOSYSTEM AND NITROGEN DYNAMICS BEFORE, DURING, AND AFTER AN

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INFLUENCE OF ENVIRONMENTAL AND CLIMATIC VARIABLES ON EASTERN OYSTER ABUNDANCE AND PERKINSUS MARINUS (DERMO) DISEASE IN TEXAS

Oyster reefs are the most threatened marine habitat on earth, with an estimated 50 to 80 percent lost from the Gulf of Mexico alone. Although eastern oysters, Crassostrea virginica, cover large expanses of many Texas estuaries, this habitat has declined due to shell dredging, storm impacts, reduced water quality, and disease (Perkinsus marinus). Long-term fisheries independent monitoring data collected throughout Texas estuaries from 1966-2008 were used to develop spatially explicit models of disease and abundance for 3 different size classes of C. virginica. Relationships between environmental predictors and biotic variables were investigated using boosted regression trees (BRT). Environmental conditions influenced abundance patterns and disease metrics for all size classes and results suggest the biotic variables are most closely linked to local salinity patterns and long-term climate variability. The BRT models were spatially interpolated using kriging to develop maps of the probability of occurrence of oysters and disease as a function of environmental conditions. These results provide practical information for managing C. virginica populations in light of future changes in climate and freshwater flows to the coast.

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NEPTUNE CANADA: REAL-TIME INTERACTIVE INFORMATION FROM THE COAST TO THE DEEP SEA

NEPTUNE Canada is operating an 800km, 5-node, regional cabled ocean network across the northern Juan de Fuca Plate, northeastern Pacific as part of the Ocean Networks Canada Observatory. Public data flow started in 2009 and interactive instruments continue to be added to this technologically challenging system which provides the continuous power and bandwidth to collect integrated real-time data on physical, chemical, geological, and biological gradients at resolutions relevant to the dynamics of the earth-ocean system. Initial experiments were planned through workshops and international competitions, and involve a number of international research teams. At coastal Folger Passage, Barkley Sound, a rocky pinnacle at 20m provides a high energy turbulent environment for a rich hardground community, and a nepheloid-dominated soft-substrate environment at 100m sees strong bottom oxygen excursions with phytoplankton remineralization. Experiments around Barkley Canyon allow quantification of changes in benthic activity with nutrient and sediment transport. There and north along the mid-continental slope, instruments on gas hydrates allow monitoring of changes in their distribution, structure, biotas and venting. At Endeavour, Juan de Fuca Ridge, complex interactions among volcanic, tectonic, hydrothermal and biological processes are starting to be quantified at the western plate edge. Visit neptunecanada.ca for information and opportunities.

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IS THERE ANY AIR DOWN THERE? USING MULTIPLE 3D NUMERICAL MODELS TO INVESTIGATE HYPOXIC VOLUMES WITHIN THE CHESAPEAKE BAY, USA

Hypoxia is a significant ecological stressor, and has been increasing in prevalence and frequency over the last 50 years. High quality observational data coupled with models able to extend the data in space and time can be used to better understand the extent of hypoxia within systems. Management practices are often based on available observations of dissolved oxygen concentration (DO), but little information is available on how well point measurements of DO can be scaled up to metrics like hypoxic volume. To better understand uncertainties associated with hypoxic volume time-series in the Chesapeake Bay, we compared DO from Chesapeake Bay Program water column profiles to hindcasts of 2004 and 2005 from three-dimensional numerical models: the Chesapeake Eutrophication Model (CE-QUAL-ICM) and two one-equation dissolved oxygen implementations in the Regional Ocean Modeling System (ROMS). Different methods of calculating hypoxic volume from model DO simulations were used to examine the uncertainties associated with such hypoxic volume estimates, and to design alternative sampling strategies with reduced uncertainties. Overall, the volume of hypoxic water computed from the three-dimensional simulated DO distributions was greater than that computed from modeled DO at the discrete observation station locations. In addition, the average hypoxic volume from all the models provided the best match to the observations. Model results also showed that uncertainty in the hypoxic volume estimates resulting from the observed water column profiles being collected and analyzed over a period of a few days. The results showed that uncertainty in long-term hypoxic volume estimation was reduced when averaging over a longer period of time.
to derive a function that can be applied to the hypoxic volume computed from a small subset of DO stations that can be sampled nearly asymptotically, in order to produce improved estimates of hypoxic volume within the Chesapeake Bay.

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VEGETATION COMPOSITION IN THE PROGRADING WAX LAKE SUB-DELTA

The Wax Lake sub-delta is a prograding land area formed by the discharge of water and sediment from the Wax Lake Outlet, southwest of Morgan City Louisiana. This delta first began forming subaerial land in 1973 and has been growing in area at a rate of 2 km² yr⁻¹ and with a rate of front expansion of 0.2 km yr⁻¹. The gradient of elevation and island age that can be found in this system allows for an analysis of primary successional vegetation community composition. This study addresses the relationships between community composition and elevation as well as sediment characteristics, such as total organic matter, carbon, nitrogen and phosphorus, on vegetation community composition for the years 2007 through 2010. Preliminary MANOVA suggests that elevation has a strong effect on the plant species found at either the high end of the elevation gradient (60 to 30 cm relative to mean sea level (msl)) or at the low end (-10 to -60 cm msl). The species that are found within the intermediate elevation range (30 to -10 cm msl) tend to not have a significant relationship to elevation and in this zone competition may be a stronger control on community composition. There was also a strong effect of the sampling year on many of the species used in this analysis, such as Salix nigra and Colocasia esculenta to dominate, at the lowest elevations flooding stress limits the species that occur.

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PHYSICS BASED APPROACH TO UNDERSTAND SPACE AND TIME DYNAMICS OF FRESHWATER DISCHARGE TO ESTUARIES

Quantization of freshwater discharge to estuary is vital to coastal aquatic life and several management practices and ecosystem restoration projects as it is very closely related to the salinity and chemical characteristics of the estuary. Freshwater-discharge stresses to estuary across its shoreline is often ignored, as it is difficult to measure. However, it is important to identify various sources of freshwater and their dynamics to address many critical issues such as water quality. In this research, the Penn State Integrated Hydrologic Model (PHIM) is used to investigate the spatial and temporal behavior of freshwater discharge from Rhode River, an experiment watershed operated by Smithsonian Environmental Research Center (SERC). PHIM is a multi-process, multi-scale hydrologic model where the major hydrological processes are fully coupled using the semi-discrete finite volume method. The model provides flexibility to partition streamflow, direct surface and groundwater discharges to estuary across its shoreline. Model estimates that the direct groundwater discharge to estuary is substantial (overall approximately 25% of total discharge annually) as compared to baselowe to streams. Particularly, during dry periods they are really significant (i.e. groundwater discharge to the estuary is approximately 43% of the total discharge). Wide time and space variability in direct discharge show that, it depends on many parameters: temporal parameters such as precipitation event and tidal conditions; and spatial parameters such as topography and soil/geologic hydraulic properties.

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INVESTIGATING LIVING SHORELINES AS A FORM OF SHORELINE PROTECTION IN NEW JERSEY

Developed shorelines are often stabilized with hardened structures such as seawalls, bulkheads, revetments, rip-rap, gabions, and groins to protect coastal properties from erosion. While hardened structures reduce property damage, the rate of coastal erosion typically increases near stabilization structures, impacting natural habitats, spawning grounds, recreational opportunities, and public access. Additionally, tidal wetland migration is impeded because coastal development, shore protection structures, and resultant changes in sedimentation interfere with the dynamic equilibrium of the shore. Currently, bulkheads and revetments are the primary form of shore protection utilized along tidal areas. To combat coastal erosion and wetland loss along coasts, many states are mitigating the problem through the creation of living shorelines. Living shorelines provide long-term protection through restoration or enhancement of vegetated shoreline habitats. There are, however, many barriers to implementation of living shorelines in New Jersey, such as a lack of understanding of the many types of living shorelines, the time commitment required for installation, cost, and the difficulty in obtaining permits for construction. The New Jersey Coastal Management Office is evaluating the use of living shorelines as a major strategy for shore protection in the state and is working to develop a plan that addresses barriers to implementation. In doing so, multiple types of data (e.g. location of shore protection structures and coastal erosion rates) will also be collected and analyzed to understand the potential for living shoreline construction statewide and make projections about impacts they may have on erosion rates and storm surge inundation.

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ECOLOGICAL THRESHOLD RESPONSES BY ESTUARINE FAUNA TO SHORELINE DEVELOPMENT WITH POTENTIAL MANAGEMENT SOLUTIONS

Documented negative effects of hardened shorelines and altered riparian land use on adjacent nearshore ecosystems include a reduction in biodiversity, habitat loss, disruption of terrestrial inputs, and water quality degradation. In Chesapeake Bay, at both local and small watershed scales, we and others have determined that an ecological threshold of ~20% development (urbanization) is associated with reduced biotic integrity in fish, benthic, bird, and marsh communities. The combination of shoreline hardening (bulkhead) with highly developed riparian land use was related to the lowest diversity and evenness of fish communities as compared to natural shorelines and those with hardening and minimal riparian development. An indicator of the land-water nexus was the relatively abundant structural habitat including marshes, SAV, woody debris and oyster and mussels beds along shorelines without hardening. At a regional scale, more than 32% of riparian lands along Bay tidal waters are developed and 19% of shoreline hardened with unknown consequences for the functioning and resilience of its coastal habitats. In response, an increasingly popular alternative to traditional armoring of shorelines is the use of natural elements, such as vegetation, to protect shorelines from erosion, while providing habitat and water quality ecosystem services. Coining “Living Shorelines” in Chesapeake Bay, there remains significant uncertainty regarding the benefits and impacts associated with natural shoreline protection designs. We are intensely surveying shoreline types (marsh-sill living shoreline, natural marsh, intertidal flats, and riprap revetment) to distinguish differences in ecosystem service provision and shoreline stabilization function. Research results will support the development of restoration performance measures and inform regulators on the trade-offs involved in habitat conversion associated with various shoreline protection techniques.

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BIOTURBATION’S GREEN THUMB: THE ROLE OF INFANNA IN Z. MARINA SEED BURIAL

In terrestrial systems, seed burial has become widely recognized as an important process influencing both small- and large-scale plant population patterns. There is a wealth of information on the mechanisms dominating the burial of terrestrial seeds, but very little is known about seed burial in seagrasses. Zostera marina, or eelgrass, is a perennial seagrass found in northern temperate oceans throughout the world, and is the dominant seagrass found in the Chesapeake Bay. The research presented here aims to identify the role benthic infauna play in the burial of Z. marina seeds. During the summer of 2011, sediment cores (80cm x 11cm) were collected from the Chesapeake Bay and defumated by freezing. The cores were thawed, and a single infaunal individual was added to each core. The organisms used were: Amphibrite sp (a head-up feeder), Clymenella torquata (a head-down feeder), and Neanthes sp (an errant feeder). Control cores were frozen, and no animals were added. 10 Z. marina seeds were placed on the surface of each core, and the burial depth of each seed was determined after 2 weeks by sieving each core in 0.5cm increments. Preliminary work with Pectinaria gouldii (a head-down feeder) shows a clear potential for infaunal seed burial, with seeds buried up to 7cm after 2 weeks. This current work will begin to determine if infauna can bury Z. marina seeds, and the differences in burial rate between different infaunal feeding groups.
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MIA-MI D-ADE COU NTRY MUL-TI-DECADAL SURFAC-E WATER QUALITY DATABASE FOR BISCAYNE BAY AND ITS WATERSHED: UTILITY IN MANAGEMENT, MODELING AND POLICY DEVELOPMENT

Researchers and managers consistently seek data on environmental conditions (i.e., historical, status & trends, rate of change). With the heightened focus on the role multi-decadal processes play in driving our regional systems and global climate, the need for and utility of long-term databases has become more prominent. Miami-Dade DERMS, in partnership with the South Florida Water Management District, State of Florida, and other partners initiated a water quality monitoring program within Biscayne Bay in 1979. The program was initiated to document physical and chemical surface water quality conditions in the Bay, and was expanded to include the major drainage canals discharging to the Bay in 1988. Monthly sampling has documented physical, nutrient, bacteriological and contaminant concentrations within the Bay and watershed. The database presently contains more than 1 million records, and has served as the basis for, or in support of: - Development of multiple numeric and statistical models of the hydrodynamics and nutrient loadings/dynamics of the Bay, - Development of local and regional restoration performance measures, targets and goals, - Documentation of long-term trends in water quality within the Bay, - Identification, duration and magnitude of episodic disturbances (tropical storms/hurricanes) and resultant system imbalances, - Development of management and planning tools, and refinement of regulatory requirements that protect the Bay, - Identification of contaminant sources to the Bay, and the effects of associated remedial actions, - State of Florida, US EPA and resource agencies efforts in development and assessment of potential numeric nutrient criteria for the Bay and freshwater canals of South Florida, - State’s ‘Impaired Waters Rule’ assessment for surface waters of Miami-Dade County. Despite their demonstrated need and utility, monitoring programs that generate and sustain these databases, continue to be jeopardized by diminished support.

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FLUSHING OF CONSERVATIVE TRACERS FROM INTERTIDAL AREAS

Four recording fluorimeters monitored the transport and removal of a slug of Rhodamine WT dye released in a tidal creek that flushes a large intertidal marsh area. The dye was released at the beginning of the flood phase of the tide. Two of the stations were located upstream of the of the release point; the other two were downstream. Currents were recorded at three of the four stations, and water level was recorded at all four. The first flood tide delivered maximum dye concentrations to the upstream stations; the first ebb tide delivered maximum concentrations to the downstream stations. The evolution of the dye cloud is described using aerial photographs from a helicopter and the fluorometer signals from the recorders. The evolution of the dye pattern throughout the tidal creek and intertidal areas compares favorably with simulations from a hydrodynamic model coupled to a conservative-tracer transport module. Model results are described in a companion paper. Exponential fits of the decrease in dye concentration over time were remarkably consistent at all four stations. The exponents of decay rate indicate that approximately 64 to 70 percent/day of the original dye mass was flushed from the system. R2 values of the fits range from 0.94-0.96 at all four stations. Since the strength of tidal energy decreases significantly at the four stations as a function of their distance upstream, the similar flushing rate throughout the system suggests that the morphology of the intertidal area plays an important role by providing a common high-friction retention area throughout the system.

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EFFECT OF DIURON AND IMAZAMYR HERBICIDES ON PHYTOPLANKTON IN THE SAN FRANCISCO ESTUARY IN AN EXPERIMENTAL STUDY

Herbicides may be used widely within estuarine watersheds and have the potential to negatively affect estuarine organisms living downstream of the site of their application. Diuron is one herbicide of concern in the northern San Francisco Estuary (SFE) because it is used extensively and persists for long periods in the environment. Despite measured concentrations in the SFE, little is known about the potential impact of diuron on phytoplankton communities. A second herbicide in use in the SFE is imazapyr, which is applied to marsh habitat adjacent to the SFE to control invasive plants. Imazapyr is not currently monitored in the SFE. This study investigated the effects of additions of diuron and imazapyr on carbon assimilation, nitrogen uptake and community composition of natural phytoplankton assemblages collected in the SFE. Diuron reduced carbon assimilation number at concentrations as low as 1 μg L⁻1 during both acute (t=0hr) and chronic (t=48 hr) exposure treatments. This concentration is within the range of diuron concentrations previously reported for the northern SFE. Imazapyr exposure did not negatively affect carbon assimilation number during acute exposure, but carbon assimilation number decreased with the addition of 5 mg L⁻1 imazapyr in chronic exposure experiments. These results highlight the need for regular monitoring of herbicide concentrations in estuaries that are near urban and agricultural centers.

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USING RECLAIMED OYSTER SHELL TO RESTORE SUBTIDAL REEF HABITAT IN SOUTH TEXAS

Oysters are an important ecological and economic resource. They provide essential fish habitat, clean bay waters, and support a valued fishery. Yet, oyster reefs are the most threatened marine habitat on earth, with 85% lost globally in recent decades. Though efforts to restore oyster habitat have increased, more effective methods of quantifying restoration success are needed. The traditional measure of success, “footprint” or acreage, means nothing if the reef is not functioning to provide the ecosystem services, or benefits, associated with oyster reefs. This summer, over 1600 cubic yards of crushed concrete and oyster shell collected from local restaurants was used to restore nearly 4 acres of oyster reef habitat in Copano Bay, Texas. In order to maximize available resources, we designed a 3-dimensional reef complex with eight reef mounds of high vertical relief. We hypothesize that these structurally complex, high-relief reefs will be less subject to sedimentation, support higher oyster densities, and support larger fish populations, and thus, will be more successful in providing the important ecosystem services associated with oyster reef habitat. We will monitor the restored reef for two years to assess ecological function and the provision of several ecosystem services. A quantitative model will be developed that will serve as a tool for guiding restoration projects and increasing understanding of structural and functional properties and processes of oyster reef habitat, and the ecosystem services they provide.

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INCREASES IN SOIL NITROGEN ALTER SHORT-FORM SPARTINA ALTERNIFLORA ROOT AND SHOOT GROWTH DYNAMICS IN A VIRGINIA SALT MARSH

Approximately two-thirds of the salt marshes on Virginia’s Eastern Shore increase in elevation predominantly through accumulation of organic matter that is derived from root and rhizome production. Eutrophication of these coastal waters may alter root production potentially influencing the ability of marshes to increase elevation in place with rising sea level. Urea, was applied to short-form Spartina alterniflora in total amounts of 0, 30, 100, or 300 g N m⁻² over six consecutive monthly fertilizations beginning in March, 2010. Belowground and aboveground production dynamics were assessed monthly using root ingrowth cores and clipping, respectively. Soil porewater was collected monthly from equilibrators and analyzed for ammonium, phosphate, and sulfate concentrations. Plots that received additional nitrogen displayed about a 50% increase in aboveground biomass production compared to the controls, regardless of N application rates. Plots receiving the two highest nitrogen amendments exhibited consistently lower root production than controls (68% to 88% less).
although differences were not significant due to high variation among replicates. At the lower fertilization rate, root production did not differ from the control. Correlations of roots and foliage exhibited a dose response to fertilization; increasing tissue N content was associated with increasing amounts of fertilizer. Discrepancies among published reports of root response to N fertilization may be a consequence of the different amounts or types of fertilizers used in those studies. At very high N application rates, there is a potential to decrease root and rhizome growth thereby slowing organic matter accumulation in marsh soils with possible consequences for maintenance of the marsh elevation. Our results do not rule out a similar effect with lower application rates over extended periods of time.

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INVASIVE COPEPODS AND PLANKTON DYNAMICS OF THE LOWER COLUMBIA RIVER ESTUARY

As part of a multi-year field study to investigate plankton dynamics in the lower Columbia River estuary, we conducted monthly sampling at a station near Astoria, Oregon. We sampled hydrography, chlorophyll, nanoplanckton, microplankton, and mesozooplankton. In addition to the description of seasonal variation in the plankton community and relationships to environmental predictors, we sought to better understand the linkages between different taxonomic groups and the role of native vs. non-indigenous copepods. To this end, we performed group-specific ordinations and cluster analyses that related community composition to both environmental and biological variables. While all plankton communities displayed strong seasonal cycles and were correlated to freshwater discharge and salinity, analyses also suggested large inter-group differences. Unlike heterotrophic communities, the diatom community was not strongly associated with a temperature gradient. Both diatom and microzooplankton communities were related to predator forcings. Conversely, the mesozooplankton community lacked strong relationships with potential prey groups, with the exception of total nanoplanckton. The copepod community was numerically dominated by Eurytemora affinis, Coullana canadensis, and Pseudodiaptomus forbesi. During summer, the non-indigenous P. forbesi dominated and we also saw peak abundances of Limnoithona tetraspina, another non-indigenous copepod. These results indicate that plankton communities in the lower Columbia River estuary are strongly influenced by both biological and physical processes, with the relative importance of these processes varying between different groups of plankton. On-going analyses will include examination of potential relationships between specific size classes of nano- and microplankton and mesozooplankton community composition, particularly with respect to native vs. non-indigenous copepods.

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COASTAL URBANIZATION IMPACTS ON THE PHYTOPLANKTON COMMUNITY COMPOSITION IN GALVESTON BAY, TEXAS, USA

The Galveston Bay Estuary faces some of the greatest conservation challenges of any system in Texas. Within this watershed are the most populated and industrialized areas of the state: the Dallas/Fort Worth metroplex and Houston. With the rapidly increasing urban sprawl in coastal municipalities, the challenge to meet human needs for water while maintaining critical freshwater inflows will be the greatest challenge for resource managers and scientists in the coming years. These inflows are necessary for salinity, nutrient, and sediment loading regimes adequate to maintain productivity of economically important and ecologically significant species. Our on-going monitoring project (Jan 2009 to now) uses a Dataflow, a flow-thru water quality instrument, to map temperature, salinity, chlorophyll, dissolved organic matter, and water clarity across the surface of the Bay. Discrete water samples are also collected for dissolved nutrient and IPIC analysis, the latter which is used to estimate the phytoplankton community composition. In addition, using GIS, we mapped land use/urbanization changes in the watershed. We found that spatial and temporal distributions of water quality data (including nutrients and phytoplankton communities) are dependent on the magnitude and duration of freshwater inflow events. Defining antecedent conditions however was more critical in describing patterns which we found to be different in the northern versus southern sections of the Bay. Our findings will ultimately be valuable in helping us understand the effects of urbanization, altering freshwater inflow events and nutrient loading on primary productivity for the Galveston Bay ecosystem.

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TIDAL WETLANDS IN THE DYNAMIC HYDROLOGIC REGIME OF THE LOWER COLUMBIA RIVER AND ESTUARY

The 724,025 km² Columbia River basin produces the largest discharge of any river on the West Coast of North America. While its estuary is relatively undeveloped, modifications in the past century from dams, water diversion, dredging, and diking have been significant. These modifications have resulted in dramatic changes in the tidal wetlands of the estuary, including a >50% loss of area, substantially different hydrologic patterns, and newly created wetlands from dredged materials. While it is difficult to compare today’s wetlands to those historically present due to lack of historical data, research on the controlling factors influencing plant community location and distribution provides insight into the changes that have occurred. In turn, this research has the potential to inform our understanding and prediction of future changes from the effects of climate change. This presentation will give an overview of the existing wetland patterns of the estuary, focusing on hydrologic and vegetation data collected at over 50 tidal wetland sites between 2005 and 2010. Specifically, the vegetation assemblages present, the elevation ranges at which they occur, and the inundation patterns that result in their current distribution will be discussed. Additionally, inundation patterns will be compared to historical hydrologic conditions and climate-driven hydrologic scenarios in order to evaluate potential vegetation community response and change.

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ASSESSING ECOLOGICAL INTEGRITY USING AN ECOSYSTEM-BASED APPROACH WITHIN THE EUROPEAN MARINE STRATEGY FRAMEWORK DIRECTIVE: THE CASE OF THE BASQUE COUNTRY (BAY OF BISCAY, NORTHERN SPAIN)

The implementation of the Marine Strategy Framework Directive (MSFD) is directing European marine research towards the coordinated and integrated assessment of sea environmental status, following the ecosystem-based approach. The MSFD uses a set of 11 descriptors (biodiversity, alien species, exploited resources, food-webs, eutrophication, seafloor integrity, hydrographical conditions, contaminants in the environment and fish, litter and introduction of energy) which, together, summarise the way in which the whole system functions. As such, the European Commission has proposed an extensive set of indicators (56), to assess environmental status or ecological integrity. Hence, taking account of the large amount of data available (around 25 years of data) for the Basque coast (southern Bay of Biscay), together with a recent proposal for assessment within the MSFD, an integrated environmental status assessment approach is developed (for the first time) in this contribution, including the reliability of the methodology. The final assessment indicates that this coast is in good status; however, some human pressures, such as fishing, are affecting fish mortality, food webs and biodiversity: The assessment provides information to take management actions in these descriptors, increasing the integrity of the offshore ecosystems. The strengths and weaknesses of the method, combined with proposals from the MSFD, are discussed.
Dissolved oxygen (DO) conditions are an important indicator of healthy ecosystem dynamics for Puget Sound, a fjord-type estuary which is part of the Salish Sea. A key driver affecting DO levels in this region is water exchange between inland marine basins and the Pacific Ocean, naturally low in DO. Large-scale weather and climate forcings, hydrodynamic processes, and freshwater influences all drive the variation in the physical processes of vertical mixing, circulation and residence time. Biochemical processes along with local human activities additionally modify DO conditions, over both variable space and time scales. We have developed a tool which sensitively tracks the deficit in DO levels in a highly dynamic environment to determine key drivers of DO conditions. We normalize the deficit, or the measure of under-saturated DO conditions, using a median calculated from our long-term monitoring data collected at core stations in Puget Sound thus establishing baseline conditions that are specific to season and station location. Anomalies in baseline conditions capture the severity and extent of low oxygen and further allow us to distinguish complex processes and separate them from seasonal variability. Furthermore, we use DO anomalies to explore the effects of large-scale climate and local processes on oxygen availability through correlation analyses. Previous analysis of the surface mixed layer, for results from 1999 – 2008, showed significant correlation between the DO deficit and biochemical factors such as changes in nitrate and phosphate concentrations, and no significant correlation with climate forcings such as the Pacific Decadal Oscillation (PDO). Further analysis of the entire water column using this tool will examine changes in frequency, extent and duration of low oxygen events in order to provide insight on controlling factors of a key water quality indicator.

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DEVELOPMENT OF A COHORT POPULATION MODEL FOR BURROWING SHRIMPS IN PACIFIC NORTHWEST ESTUARIES

Surveys for the burrowing shrimps, Neotrypaea californiensis and Upogebia pugettensis demonstrated significant declines in populations of both species over the last decade. Consistently low recruitment has impacted shrimp density and population size, raising concern over the long-term sustainability of shrimp populations in PNW estuaries. Efforts are currently underway to develop a predictive cohort-based population dynamics model for both U. pugettensis and N. californiensis. The cohort-based model includes estimates for rates of growth, recruitment and mortality obtained through annual population monitoring surveys conducted in Yaquina Bay, Oregon and Willapa Bay, Washington from 2007 to present. Because previous work has shown body size to be weakly correlated with age at a given actual age in burrowing shrimp, age structure within these populations will be obtained using analysis of the aging pigment, lipofuscin, as an alternative to size-based aging methods. Age structure information determined though analysis of lipofuscin will then be used to derive growth and mortality parameters in the cohort models. Once verified these models can be used by managers to make predictions about future changes in shrimp populations and the resulting impact on PNW estuaries.

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EVALUATING VARIABILITY IN NEKTON DISTRIBUTION, HABITAT ASSOCIATION AND BEHAVIOR WITH HIGH RESOLUTION IMAGING SONAR

Ecosystem processes in estuaries occur over a continuum of spatial and temporal scales, but seldom do the observations match the scale of action, or are severely limited to only a few spatial or temporal dimensions. We review recent advances in imaging sonar technology that are helping to overcome the limitations of understanding variability in nekton distribution, habitat association and most recently, nekton behavior. Specifically, we address the applied and analytical approaches that offer quantitative metrics to provide significant insight into important ecosystem processes: from individual behavior and energetics, to trophic interactions, to population and community dynamics. We highlight the use of advanced technologies in estuaries and coastal ecosystems and compare the performance, utility, challenges and benefits of their use in these challenging and dynamic environments. Specific examples are shown from the Neuse River Estuary in NC and tidal marshes in the northern Gulf of Mexico. We demonstrate that meteorological conditions greatly affect the most influence on collection and quality of data, particularly for shallow-water acoustics.

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SUBLATIONAL EFFECTS OF POLLUTION ON HORSESHOE CRAB EMBRYOS: RESPONSES TO OXIDATIVE STRESS CAUSED BY EXPOSURE TO COPPER AND CADMIUM

Horseshoe crab (Limulus polyphemus) embryos developing in polluted estuaries may be exposed to metals such as copper and cadmium. Both metals reportedly generate reactive oxygen species (ROS) that, in turn, may damage cellular lipids and proteins, as well as DNA. In this study, we exposed stage 20 L. polyphemus embryos to concentrations of Cu (as CuSO4) and Cd (as CdCl2) from 0.01 to 100 mg/L for four different time intervals ranging from 4 h to 24 h. These treatments were sublethal (except 24 h exposure to 100 mg/L Cu); however, metal exposure led to a general delay in developmental rate. Embryos exposed to Cu showed evidence of damage related to oxidative stress, as demonstrated by an increase in protein carbonylation and lipid peroxidation relative to seawater controls. To cope with oxidative stress, all organisms use the superoxide dismutase enzymes (SOD’s) that convert the superoxide radical (produced in mitochondria) to O2 and H2O. Embryos exposed to Cu or Cd exhibited an increase in the levels of SOD’s (as determined by immunodetection on Western blots) and in the specific activity of the enzyme (as assayed using a colorimetric kit, Dojindo Molecular Technologies). In general, the levels and specific activity of SOD’s were higher in metal treatments compared to controls, although there was no clear correlation between the concentration of Cu or Cd and the levels or specific activity of SOD. Overall, increases in SOD level and activity appear to be physiological mechanisms by which developing L. polyphemus embryos can survive oxidative stress caused by sublethal concentrations of metals in the environment.

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RESOURCE PARTITIONING AMONG FISH MESOCOMSUMERS ALONG A MARSH-MANGROVE ECOTONE: A RESPONSE TO A PULSED SEASONAL RESOURCE SUBSIDY

Consumers throughout natural ecosystems are often subdued by pulsed resources. At the onset of the pulse, high numbers of consumers are able to simultaneously exploit additional food sources. However, as resources become depleted, competition increases such that the extent to which organisms are supported by these pulsed resource subsidies will likely depend on the competitive abilities of individuals and species. In the Greater Everglades Ecosystem, hydrologic seasonality influences ecosystem processes, including prey

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availability along the marsh-mangrove ecotone. In the dry season, decreasing water levels in upstream marshes force fish into tidal mangrove creeks. At the same time, ecotonal abundances of estuarine transient consumers, dominated by snook (Centropomus undecimalis) triple, likely in response to increased freshwater prey abundance. In this study, we examine how snook seasonally partition resources with spatially co-occurring freshwater fishes (e.g. largemouth bass Micropterus salmoides), Florida gar (Lepisosteus platypterus), and bowfin (Amia calva) in the upper Shark River Estuary in Florida, USA. We examined percentage of empty stomachs, gut fullness, diet breadth and percent diet overlap from stomach contents obtained from the 4 species via pulsed gastric lavage. We hypothesize that 1) when resources are highly available at the onset of the pulse, feeding intensity diet breadth and percent dietary overlap will be high and will not differ across species, however 2) in the late dry season when resources diminish, consumers will begin to differentially select resources based on their competitive abilities. Results indicate that in the early dry season, consumer diets overlap, as all species exploit marsh-based prey. But, as freshwater prey become less abundant later in the dry season, diets segregate strongly. These data suggest that marsh hydrology can dramatically impact trophic dynamics and energy flow in the upper estuary.

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THE MULTISCALE INTEGRATED MODEL OF ECOSYSTEM SERVICES (MIMES): THE CLASSIFICATION, DYNAMICS, MODELING AND VALUATION OF ECOSYSTEM SERVICES

Ecosystem services are defined as those functions of ecosystems that support human wellbeing. They occur at multiple scales, from climate regulation and carbon sequestration at the global scale, to flood protection, soil formation and nutrient cycling at local and regional scales. The MIMES aims to integrate scales through participatory model building, data collection and valuation, to advance the study of ecosystem services. Applications are integrated assessments that build on the GUMBO model approach to allow for spatial explicit modeling at various scales. The three major objectives are: 1 A suite of dynamic ecological economic models aimed at integrating across a range of spatial scales, 2 Development of new valuation techniques adapted to the public goods nature of most ecosystem services, and 3 Delivery of the integrated models and their results to a broad range of potential users. MIMES Ecosystem services are the interface between the natural spheres, (the production or supply side) and the anthroposphere (The consumption or demand side), where natural amenities are evaluated for their contributions to the economies and well-being of human cultures. Where MIMES is used to represent a spatial explicit model, exchanges between locations can be coded to represent not only flows of water, air and people but also the spread of species. Subject-specific models relevant within the MIMES are implemented within the MIMES model framework. MIMES development is applied to a range of case studies, to include a global implementation, land-use changes within the Altimelake Panmico watersheds in Virginia and North Carolina, and to guide ecosystem based management decisions in Stellwagen Marine Reserve, Massachusetts. Most recently MIMES was applied in simulating global climate change on Human health outcomes for the City of Austin, Texas.

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ESTIMATING CLIMATE CHANGE INDUCED SHIFTS IN WATER SUPPLY FROM COASTAL LAKES ON THE NORTH SLOPE OF ALASKA USING THE NORTH SLOPE DECISION SUPPORT SYSTEM

The coastal lakes on the North Slope of Alaska meet many water resources needs. They are often home to multiple fish species, some of which are endangered. They supply water to local peoples, and animals. And, they are used as sources of water for ice road construction. A full description of the NSDSS technology will be presented in addition to a demonstration of the system. The system allows users to publish their water budget models, so that other users can use them in ice road planning. A full description of the NSDSS technology will be presented in addition to the water budget modeling analysis.

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A WEB-BASED TOOL FOR ESTIMATING CLIMATE CHANGE INDUCED SHIFTS IN STORM INTENSITY AND FREQUENCY IN FLORIDA

Coastal, low-lying Florida is perhaps the United States’ greatest area of concern in the face of climate change and rising sea level. Over the next century, sea level is projected to rise approximately 1m in this area, while storms are expected to increase in intensity and frequency (IPCC, 2007). Yet, few easily accessible and user friendly tools exist for estimating climate change induced shifts in storm intensity and frequency. In fact, few tools exist for even accessing general circulation model circulation model results – the models which are typically used to estimate climate change impact. Moreover, methodologies for using GCM results to forecast storm intensity and frequency shift have yet to mature, resulting in a lack of forecasting tools that can be readily accessed. In this presentation, we will present a new web- and map-based tool for estimating climate change induced shifts in storm intensity and frequency based on local historical weather data and GCM-based projections of weather into the future. Using a new web service that provides map-based global GCM projections from five different models for four different greenhouse gas control scenarios per model, this tool creates an ensemble 2010-2060 forecast of storm intensity and frequency for the location of interest. The methodology implemented focuses on using shifts in temperature and rainfall statistics projected by the GCMs to estimate shifts in the parameters of the exponential distribution of rainfall events measured historically at the target location. Results to date will be presented.

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EFFECTS OF RESTORATION ON ECOSYSTEM STRUCTURE IN TROPICAL SEAGRASS MEADOWS

Shallow seagrass ecosystems near population centers frequently experience physical disturbance due to vessel groundings. Resource managers attempt to accelerate recovery of disturbed seagrass habitat by implementing specific restoration methods that modify physical, chemical, and biological aspects of the disturbances. The objectives of this study were to document the loss and recovery of ecosystem structure in physically disturbed seagrass beds, as well as the efficacy of common seagrass restoration techniques. Sediments, porewater, microphytobenthos, macroinvertebrates, and macrophytes from unrestored and restored seagrass groundings sites are from intact seagrass beds in Biscayne National Park were evaluated. Results indicate that vessel groundings destroy seagrass ecosystem structural attributes essential to nutrient exchange, ecosystem metabolism, and habitat quality. Seagrass ecosystems disturbed by vessel groundings recover lost structure with time through succession and ecosystem development, though this recovery is slower than previously anticipated. Seagrass restoration actions such as fill placement and bird stake installation affect nutrient exchange and sediment metabolism variables, and may accelerate the recovery of ecosystem structure over longer time frames. As theoretical and experimental groundwork in seagrass restoration is now being scaled up into restoration projects, it is critical to ensure that restoration practices are based upon and evaluated in the context of established ecological concepts.

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SHEEDING NEW LIGHT ON DENITRIFICATION IN SALT MARSHES: WHAT CAN WE LEARN FROM THE DEEP DIVERSITY OF NRIs GENES IN THE GREAT SIPPENWISSETT SALT MARSH FERTILIZATION PLOTS?

Microbially mediated denitrification is an incredibly important component of the ecosystem services provided by salt marshes because it is a primary mechanism for the removal of land-derived nitrogen. Anthropogenic nitrogen that is derived on land ultimately finds its way to the coastal ocean where it can stimulate primary production and, if in excess, can lead to eutrophication of coastal waters. Denitrification, the conversion of fixed nitrogen to nitrogen gas, is one mechanism that can ameliorate the threat of eutrophication, yet very little is known about the microorganisms that are responsible for this process. The nirK gene encodes a nitrite reductase enzyme that catalyzes a necessary step in the denitrification pathway. Examination of this gene in the environment can give us a measure of the diversity of organisms capable of the process and allow us to decipher the conditions under which denitrification is optimal. Quantifying the nirK gene is possible using qualitative PCR but this cannot provide specific information regarding genetic diversity. Clone libraries, by contrast, provide information on genetic diversity; but are so labor intensive they cannot be
used to look deeply at the population structure. Here I demonstrate the first application of high throughput sequencing to the nitS functional gene. I show that we are able to recover deep diversity of the gene in the environment and I compare genetic diversity of the denitrifiers in salt marsh plots that have received varying doses of fertilizers over the last four decades.

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ECOLOGICAL RE-ENGINEERING OF A FRESHWATER IMPOUNDMENT FOR SALT MARSH RESTORATION IN A HYPERTIDAL SYSTEM

The purpose of this paper was to examine the vegetative, sedimentary, nekton and hydrologic response to ecological re-engineering of a freshwater impoundment in the Upper Bay of Fundy, Canada. The dyke was breached in five locations and one channel initiated to connect the river to the borrow pit behind the dyke. This triggered significant self-organization within the restoration site. Existing channels (e.g. borrow pit) were incorporated within the newly excavated and developing creek system, increasing the hydraulic connectivity within the marsh and increasing fish habitat. Vegetation colonization, primarily by Spartina alterniflora, was rapid with almost 100% coverage by the end of the third year, with high marsh species (e.g. Juncus gerardii, Scirpus robustus) present in increasing abundance by year five. The constructed channel experienced considerable morphological change in response to the increased tidal prism. In the year immediately following the breach (2006), the surface of the marsh was unconsolidated and rates of change in surface elevation measured at RESIT stations ranged from −0.7 (±0.1) to 1.7 (±0.2) cm yr⁻¹ (±1 SD). By year three the rate of surface elevation change decreased to a more moderate but variable mean of 0.3 (±0.6) cm yr⁻¹ with the marker horizons recording mean accretion rates of 0.7 cm yr⁻¹, implying subsurface consolidation. By year five, more subtle changes continued to be observed in the habitat structure (primary and secondary channel development, sediment and elevation) and the biological community (establishment of high marsh vegetation species, fish densities). This study represents the first comprehensive, quantitative analysis of ecological response to dyke breaching in a hypersaline ecosystem. These data will contribute to the development of long-term data sets of pre- and post-restoration, and reference marsh conditions, and has improved our ability to design subsequent restoration projects.

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“THINGS PEOPLE CARE ABOUT”: ECOSYSTEM SERVICES OF THE SOUTH FLORIDA COASTAL MARINE ECOSYSTEM (SFCME)

Ecosystem services (ES) comprise one of the 5 elements of the DPSER framework (Driver-Pressure-State-Ecosystem Services-Response) which we use to formulate conceptual models of the SFCME under our NOAA-funded, Marine and Estuarine Goal Setting for South Florida (MARES) project. ES represent the benefits that humans derive from the ecosystem. Quantitative indicators of these benefits—monetary or other—are valuable tools for crafting effective management responses to ecosystem stressors. The MARES project has defined ecosystem services as “things that people care about.” Describing the ecosystem in terms of beneficial services acknowledges that natural resources management decisions reflect human goals. Ecosystem services, quantified in economic, cultural, or social terms, provide managers with information they can use to balance environmental concerns with other objectives. ES have value both for people who directly use the ecosystem and for those who may use it indirectly. The DPSER framework differentiates ES from State variables, components of the coastal marine environment like fish, coral, etc. The processes connecting State variables, e.g. nutrient cycling, primary production, etc. are inherently important but are not ES. MARES identifies 18 different ES provided by the SFCME as categorized by the type of benefit they provide: cultural, regulating, and provisioning. Cultural services are non-material benefits such as spiritual, recreational, aesthetic, educational, cultural heritage, etc. Regulating services are benefits obtained from ecosystem processes such as climate regulation, disease regulation, water purification, etc. Provisioning services are products obtained from ecosystems such as food and pharmaceuticals. We believe that providing the managers, decision-makers, and the public with quantitative indicators of ecosystem services will prove to be valuable in crafting effective Responses to stressors and for maximizing Ecosystem Services for future use.

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NOVEL ROLE AND INTERACTIONS OF AN INTRODUCED AMPHIPOD IN SAN FRANCISCO BAY EELGRASS BEDS

Through a series of field observations and experiments, we evaluated the role of an invasive amphipod, Amphithoe valida, a eelgrass (Zostera marina) bed in San Francisco Bay (SFB). Not known to consume eelgrass in its native range of the U.S. East Coast, the amphipod can produce extensive damage to blades and inflorescences in this invaded habitat. In an experiment in which SFB A. valida was offered eelgrass tissues from both SFB and its native Virginia, SFB tissues were by far the preferred choice and consumed even when a common macroalga was also offered. Tissue nitrogen concentration was higher in SFB tissues, but neither nitrogen nor phenolic content of eelgrass tissues from the two locations provide clear or adequate explanations for this response. A separate experiment showed that two common native fishes of SFB were much less effective at reducing abundances of A. valida than a fish species brought in from the amphipod’s native range; hence, in SFB, amphipod population growth and effects may be enhanced in part by reduced predation pressure. Other experimental results indicate the amphipod’s preference for consuming inflorescences with well-developed seeds over vegetative blades and that flowering shoots increase provision of refuge from native predatory fish. This invasion presents concerns for eelgrass restoration in SFB, where restoration projects frequently rely on collection of intact flowering shoots for seeding, restored plants have especially low tissue carbon:nitrogen, and it may take time to attract predators.

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A CASE STUDY OF THE BACK RIVER ESTUARY: STRONG MANAGEMENT ACTIONS AND ECOLOGICAL LAG TIMES

The Back River estuary is a small tributary (length = 14 km; depth = 2 m) of Chesapeake Bay located on the upper western shore adjacent to Baltimore, Maryland. The basin is largely urban (41% impervious), and a large waste water treatment plant (WWTP) has been discharging into the upper estuary since 1912. Advanced waste water treatment began in 1990, and more recently (late 1990s) seasonal denitrification has been added. A 25 year time-series of point and diffuse nutrient loads and a variety of water quality variables was examined for ecological responses to this recent management action (N removal).

Significant declines in concentrations of dissolved inorganic nitrogen, total phosphorus and algal biomass (chlorophyll-a) were evident from 1985-2007, even though nutrient input levels remained above limiting values. Water column N:P ratios were high (> 500) early in the record but decreased (1-30) during summer later in the record. We found few significant relationships between chlorophyll-a and other inorganic nutrient concentrations on monthly, seasonal or annual time scales. However, when 2-year averages for chlorophyll-a concentration and point source nutrient loads were lagged by 2-3 years, very strong ecological responses emerged, possibly suggesting a “nutrient memory” for this system. A boxmodel (salt-balance with continuity) indicated that much of the N entering this system was lost within the estuary (via denitrification and burial), and export of N to Chesapeake Bay was small. Additionally, levels of surficial sediment N in this estuary were 2-3 times higher than in other low salinity areas of the Bay, possibly explaining this apparent nutrient memory. Major conclusions were: 1) this is a local enrichment issues and can be solved with local nutrient load reductions and 2) positive water quality responses will not be immediate.

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THIS ESTUARY NEEDS A POLLUTION DIET: HOW MUCH IS ENOUGH FOR RESTORATION?

The Corsica River is a highly nutrient enriched small tributary on the upper eastern shore of Chesapeake Bay. Recent efforts by Maryland agencies have made restoration of this tributary a model for restoration elsewhere in the Bay. A key to this effort was identifying major nutrient sources and estimating what degree of reduction was needed for restoration. Land sources of nitrogen (from agricultural operations, urban runoff, atmospheric deposition and septic systems) were quantified and linked to algal biomass (chlorophyll-a). In turn,
algal biomass was linked to both water clarity and low dissolved oxygen conditions (hypoxia). Load reductions associated with septic system upgrades, agricultural BMPs (cover crops) and storm water management indicated a 50% nutrient load reduction was achievable. At this level of reduction water clarity would support benthic plant growth and eliminate hypoxia. These responses to load reductions were not linear, suggesting water quality improvements might be stronger than expected.

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ESTIMATING ORGANIC MATTER DEPOSITION AND DECAY WITH A LONG-TERM SEDIMENT FLUX DATABASE AND MECHANISTIC MODEL

Biogeochemical models are extremely useful tools to analyze and interpret time-series of observations of key estuarine variables. For example, organic matter deposition is a crucial link between phytoplankton production and associated effects on benthic-pelagic coupling. However, estimating this flux is notoriously difficult due to methodological constraints and dynamic processes such as resuspension and advection. In this study, we use a standalone version of the mechanistic two-layer sediment flux model (SEFM), which is currently implemented for Chesapeake Bay TMDL management, to estimate rates of organic matter deposition, sediment biogeochemical reactions, and sediment-water fluxes at 12 Chesapeake Bay sites over up to 16 years. A pattern search algorithm is used to estimate the organic matter deposition required to match modeled and observed long term trends in sediment-water ammonia flux. The advantage of this method is that deposition can be independently validated with measured biogeochemical rates (i.e. denitrification and sulfate reduction), porewater concentrations, sediment chlorophyll and nutrient and oxygen fluxes (i.e. nitrate, silica, phosphate, and sediment oxygen demand). Calculated deposition was similar to estimates from a sediment chlorophyll decay method and ~60% of sediment trap estimates. Estimated organic matter deposition rates are in turn used to improve model parameterization of sediment denitrification and organic matter decay rates and have led to the inclusion of processes not included in the original model development, such as temperature dependent silica solubility. Long term patterns in model-data residuals are compared with climatic drivers and water-column concentrations of nutrients and dissolved oxygen. These long-term modeling analyses provide insights into the effects of timing of organic matter deposition, the response to changes in nutrient loading, and the potential for “nutrient memory” in Chesapeake Bay sediments.

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HOW DOES HYPOXIA AFFECT HABITAT QUALITY OF FISHES?

Nutrient abatement programs to reduce the effects of cultural eutrophication are often implemented in an effort to reduce hypoxia and mitigate hypoxic effects on fishes. Yet, it is unclear how hypoxia actually affects habitat quality for fishes, particularly those in midwater. Reduced oxygen availability has the potential to cause mortality or indirect sublethal effects, including reduced feeding and growth rates, changes in behavior and distribution, and increased encounter frequency with predators or prey. Detailed analyses of spatial distributions of environmental factors and fishes in the Great Lakes, Chesapeake Bay and the Northern Gulf of Mexico suggest that spatial distributions and other habitat features, such as water temperature and the timing of hypoxia, have species and ecosystem specific effects. Indeed some fishes may actually benefit from hypoxia. Research needs to focus on these complex interactions, including the degree of overlap between predators and prey habitats, and changes in the habitat quality and growth rate potential of fishes. Comparisons across ecosystem may yield further insights into intra-specific and food-web variability in response to hypoxia and eutrophication.

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NITROGEN TRANSFORMATION IN A PROGRADING, LOUISIANA DELTA: A MODELING APPROACH

Highly eutrophic conditions in the Mississippi River and its distributaries have been cited as the primary cause of a large hypoxic “dead” zone off of Louisiana’s coast in the Gulf of Mexico. Elevated nitrate concentrations in the river (>100 um) coupled with river engineering and rapidly subsidizing coastal wetlands, have become major forces controlling ecosystem function and structure over the past two decades. To alleviate this ongoing loss of natural wetland resources as well as the offshore hypoxic condition, large scale freshwater diversions have been proposed to create active deltaic regions where land and wetlands are built by the riverine sediments. One such delta became sub aerial in the 1970’s at the Wax Lake Outlet in the Atchafalaya River Basin and continues to expand as a result of a Mississippi River diversion. We developed a nitrogen cycling model for this delta region to evaluate the fate of various nitrogenous compounds. The model incorporates sedimentation rates, pore-water diffusion, chemical kinetics and vegetative assimilation as a function of land height, river stage, vegetation coverage and environmental parameters. The model was calibrated to simulate field measurements of nitrogen storages and transformation rates measured in the period 2009-2010 along selected transects and throughout an annual cycle. Model outputs are used to identify critical nitrogen transformation processes associated with land building and wetland vegetation distribution, particularly those regulating nitrogen removal.

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INVESTIGATIONS RELATED TO THE DEVELOPMENT OF HATCHERY-BASED SHELLFISH PRODUCTION IN ZANZIBAR

The goal of this project is to engage several hundred women farmers across some six villages in Zanzibar, Tanzania, in generating collectively 50,000 to 100,000 kg of shellfish meats per year. This activity will provide a sustained and improved income stream for women shellfish farmers on the island. A central aspect of the project is the construction of a small shellfish hatchery on Zanzibar to support increased production by shellfish farmers. Together with the training capacity built by the project in local organizations and in the villages themselves, this project will develop a new, ecologically and economically sustainable source of protein for local consumption and income for women in Zanzibar’s coastal villages. The main activities are (1) construction of a shellfish hatchery, (2) scientific training to a local hatchery technicians to operate this hatchery and provide shellfish seed to the farming groups in the villages, (3) training to shellfish farmers in the growout of shellfish to market size, and (4) to provide additional business and market development training to shellfish farmers. The hatchery has supported several experiments focused on shellfish (Amadara antiqua) conditioning and spawning. Field experiments covering in situ survival and growth have also been conducted in several coastal villages.

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FISH, FOOD WEBS AND DISEASE: PREDICTING EFFECTS OF HYPOXIA AND CO-OCCURRING STRESSORS

Low dissolved oxygen results from a combination of anthropogenic and natural factors that deplete oxygen concentrations at spatial scales ranging from millimeters to thousands of kilometers and temporal scales ranging from less than a day to millennia. The effects of hypoxia on ecologically and economically important fish and shellfish depend on a wide range of factors including behavior, physiological tolerances, and the relationships between these factors and the scales of variability in dissolved oxygen concentrations. Experiments and field sampling have shown that even intermittent exposures can affect fish and shellfish growth and disease dynamics. The potential impacts of low pH associated with acidified hypoxia, and that has been a long-standing focus of physiological research, is now also becoming increasingly appreciated by ecologists. In addition to experiments and field sampling, cross-system comparisons are providing new insights into the relationships among hypoxia, nutrients, fish biomass, fisheries landings, food web structure, and ecosystem stability. A working group is addressing these linkages using a data mining approach and databases global as well as local nutrient load models and output from Ecopath foodweb models. We are also
modifying the models in order to more directly simulate individual and interactive effects of nutrient enrichment and oxygen depletion in a suite of estuaries, coastal regions and semi-enclosed seas.

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GROWTH, MORTALITY, AND RECRUITMENT OF BLUE CRAB (CALLINECTES SAPIDUS) IN RELATION TO ENVIRONMENTAL FACTORS IN THE MARYLAND COASTAL LAGOONS

Published information on the population ecology of blue crabs in the Maryland Coastal Lagoons is scarce. Data from twenty years of blue crab trawl surveys conducted by the Maryland Department of Natural Resources were analyzed to evaluate temporal patterns of recruitment, growth and mortality rates which were then related to environmental factors using regression analyses. Monthly growth rates for 0+ crabs averaged 0.7mm over the 20 year period with the highest value being 14.1mm in 2008 and the lowest being 6.8mm in 1994. Monthly mortality rates for 0+ crabs averaged 0.9 with the highest value being 1.33 in 1993 and the lowest being 0.52 in 2005. Recruitment (peak 0+ CPUE) ranged from 24.9 in 1998 to 84.4 in 2008 with an average of 52.2. Growth rate was negatively correlated to crab population density (r2=0.41, p=0.002, n=20), but not to temperature (r2=0.05, p=0.33, n=20) or salinity (r2=0.03, p=0.50, n=20). Mortality rate was negatively correlated to temperature (r2=0.32, p=0.012, n=19), but not to salinity (r2=0.03, p=0.52, n=19), or to population density (r2=0.02, p=0.38, n=19). Recruitment was negatively correlated to the ENSO Index (r2=0.43, p=0.002, n=19), but not to temperature (r2=0.08, p=0.80, n=19), or salinity (r2=0.0003, p=0.94, n=19). Yearly CPUE and average carapace width were also calculated for four size classes of crab: Age 0+ (>60mm), Age 1+ (>60mm), Size 1 Crabs (61-119mm), and Size 2 Crabs (>120mm). These indices fluctuated between years but showed no general trends or correlations to the environmental factors examined. Results from this study are useful as input data in population models for management of blue crabs in the Maryland Coastal Lagoons.

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SURVIVAL AND GROWTH OF ESTUARINE FISH FOLLOWING EXPOSURES OF CHEMICALLY ENHANCED DISPERSED OIL FROM THE DEEPWATER HORIZON OIL SPILL

To assess potential impacts of the 2010 Deepwater Horizon oil spill on coastal habitats, we are examining the effects on individual fish in laboratory exposures. Spotted seatrout (Cynoscion nebulosus) are considered a good indicator of estuarine health because they occupy a mid-trophic level, are estuarine residents and show great plasticity in their growth (Cynoscion nebulosus) are considered a good indicator of estuarine health because they occupy a mid-trophic level, are estuarine residents and show great plasticity in their growth. To assess potential impacts of the 2010 Deepwater Horizon oil spill on coastal habitats, we are examining the effects on individual fish in laboratory exposures. Spotted seatrout (Cynoscion nebulosus) are considered a good indicator of estuarine health because they occupy a mid-trophic level, are estuarine residents and show great plasticity in their growth. To assess potential impacts of the 2010 Deepwater Horizon oil spill on coastal habitats, we are examining the effects on individual fish in laboratory exposures. Spotted seatrout (Cynoscion nebulosus) are considered a good indicator of estuarine health because they occupy a mid-trophic level, are estuarine residents and show great plasticity in their growth. To assess potential impacts of the 2010 Deepwater Horizon oil spill on coastal habitats, we are examining the effects on individual fish in laboratory exposures. Spotted seatrout (Cynoscion nebulosus) are considered a good indicator of estuarine health because they occupy a mid-trophic level, are estuarine residents and show great plasticity in their growth.

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RESTORATION OF COASTAL WETLAND IMPRODUMENTS IN THE INDIAN RIVER LAGOON, FLORIDA: HISTORY, METHODS, AND MONITORING

Coastal wetlands in the Indian River Lagoon (IRL) system have been impacted by development and mosquito control since the 1920s. Most of the impacts occurred from the

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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, pressures and responses, including the impacts from anthropogenic interventions that have occurred in this region since the early 1900’s. A holistic approach to basin segmentation before NMC derivation, to account for variability not only dictated by a given nutrient level, but by the combination of imposed conditions (nutrients, geomorphology, circulation, management, etc), was selected. FIU’s water quality monitoring data at 353 fixed stations was used for basin segmentation with an objective classification of stations 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 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 the dominance of 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. If a waterbody were to be considered in good ecological condition and supportive of its designated use, the threshold would become the proposed long-term NNC.

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THE IMPORTANCE OF UNDERSTANDING SPATIAL SCALE IN AQUATIC PLANT RESEARCH: IMPLICATIONS OF GENETIC DIVERSITY AND NEIGHBORHOOD SIZE IN SEAGRASS SPECIES

We genotyped 1707 Thalassia testudinum ramets harvested across Florida Bay and ran a spatial autocorrelation revealing a clonal neighborhood size of 25m and a genetic neighborhood size of 70m. We collected 239 T. testudinum ramets from central Florida and detected clones measured in km rather than m. Meaning Florida has two populations of T. testudinum with nearly diametric population structure. A significant proportion of aquatic plant species have large geographic ranges, and data suggest that local populations may have a differential reliance on clonal vs sexual reproductive strategies. This makes it difficult to extrapolate research findings acquired at small spatial scales and apply them to larger or global models of species success, expansion, and extinction. The genetic population structures of seagrass species across regions have revealed significant differences where genetic structure is strong, detectable, or indistinct. Dominant growth strategies species have developed for initial meadow formation, followed by meadow maintenance, establish genetic population structure. It had been assumed that meadow formation occurred via the recruitment of a limited number of colonizers reliant on clonal growth. However, recent evidence on genotypic patterns shows that genetic diversity is often very high in populations where recruitment is rarely observed. Conversely, populations that exhibit variation in survivorship traits and morphology may be made up of few individuals exhibiting high levels of plasticity. This illustrates the importance of differentiating phenotypic response of a clonal population from the genotypic response of a high diversity population. In this presentation we will discuss the genetic population structure of the two dominant seagrass species on the east coast of the USA, T. testudinum and Zostera marina. We will illustrate how the spatial scale of genetic population structure can affect interpretation of research study results.

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Coastal wetlands in the Indian River Lagoon (IRL) system have been impacted by development and mosquito control since the 1920s. Most of the impacts occurred from the
late 1950s through the early 1970s. During this period, nearly 16,200 ha of wetlands were impounded for mosquito control. From the beginning, some recognized the negative ecological impacts and tried to minimize them by including culverts. Since the 1980s, over 10,830 ha have been reconnected to the estuary and are managed with culverts. However, full restoration of impoundments (scraping the lake back into the borrow ditch) was implemented as early as 1979 at Merritt Island National Wildlife Refuge (MINWR). Subsequently, impoundments have been restored for compensatory mitigated and also as part of a habitat restoration initiative. The restoration initiative began as a collaborative effort with St. John's River Water Management District, Volusia County Mosquito Control, and MINWR to restore the initial group of impoundments in 1998. Recovery monitoring, beginning in 2005, helped refine and validate our restoration methodology and documented natural regeneration of native wetland communities. Restoration of all impoundments targeted in the Volusia County portion of the IRL was completed in 2008. Work in other portions of MINWR continued, but was greatly accelerated by a NOAA Recovery Act grant. Prior monitoring helped establish required monitoring targets for the NOAA work. To date, the initiative has restored all or part of 20 impoundments, reestablishing over 69 km of shoreline, returning approximately 105 ha to wetland elevation, and enhancing the hydrologic connectivity of over 940 ha of previously-impounded coastal wetland.

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CUMULATIVE RESPONSE OF EELGRASS MEADOWS TO WARMING, NUTRIENT ENRICHMENT, AND FOOD WEB STRUCTURE

Eelgrass meadows (Zostera marina) are extremely valuable due to the ecosystem services they provide and their central role in estuarine food webs. At the southern edge of its range, eelgrass meadows in North Carolina are vulnerable to multiple stressors including nutrient enrichment and regional climate change that promote growth of algal epiphytes and reduce seagrass health. Using three-way experimental manipulation, we explored how these two stressors affect eelgrass communities in experimental mesocosms, as well as whether food-web structure (herbivores only, herbivores + higher consumers) mitigates effects of these abiotic stressors. In the absence of a higher consumer (pinfish), we expected herbivores (amphipods) to mitigate the effects of increased epiphyte load resulting from nutrient enrichment or temperature elevation. When pinfish were added, we predicted that they would cause a trophic cascade, reducing the density or grazing behavior of the amphipods, allowing increased epiphyte load, and therefore reducing eelgrass health. Preliminary results indicate that temperature reduced the overall aboveground eelgrass biomass by 90% while nutrient enrichment caused a slight increase in biomass. The presence of a higher consumer had no effect at ambient temperatures, but led to higher aboveground biomass in treatments warmed by 2°C - potentially mitigating some effects of abiotic stressors by altering population growth rates of herbivores or feeding rates of consumers. Overall, we expect stressors will have interactive effects with food-web structure on eelgrass health and the cumulative response may propagate to affect the ecosystem services that eelgrass meadows provide.

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COMUNITY ADAPTATION TO FLOOD RISKS ALONG THE GULF OF MEXICO

The Gulf of Mexico coastal margin is considered one of the most vulnerable regions in the U.S. to the adverse impacts of climate change. In particular, rapid population growth and development in low-lying areas have exacerbated risks from surge and rainfall-based flood events. For example, from 2000-2005 Gulf coast counties incurred over $52 billion in overall flood damage with $19 billion reported through the National Flood Insurance Program (NFIP). With mounting losses from flood events and the increasing threat of climate change, decision makers are beginning to focus on how to construct more resilient coastal communities over the long term. While little research has been conducted on defining and measuring indicators of disaster resilience, even less work has been done to test their effectiveness in protecting localities from persistent risks associated with climate change along the Gulf of Mexico coast. We address this issue by examining indicators of ecological resilience and their interaction with the human built environment across 144 counties bordering the Gulf of Mexico. Specifically, we identify and measure four indicators of resiliency, then statistically test the degree to which they reduce flood losses observed across the area study over a five-year period. The results are presented in both visual and statistical formats to highlight the effects of each indicator on flood losses. We map indicators using Geographical Information Systems (GIS) and analyze multiple regression models to isolate the influence of each indicator on flood damages while controlling for local contextual variables. Our findings support the notion that specific features of the natural environment moderate the effects of floods and provide a foundation for building resilient human communities. Local and regional policy makers can use this information to develop more flood-resilient communities and reduce the amount of flood losses accruing along the Gulf coast.

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THE PROBLEM OF EFFLUENT ORGANIC NITROGEN

Concentrations of dissolved inorganic nitrogen (DIN) in many marine systems are near the limit of detection because it is rapidly taken up by microbial communities as soon as it becomes available. In contrast, concentrations of dissolved organic nitrogen (DON) are relatively high. This relationship led to the view that DON was not available to phytoplankton for growth and is therefore considered refractory. Much like marine systems, the concentrations of DIN in effluent from wastewater treatment plants (WWTPs) with advanced biological nutrient removal (BNR) is also low while concentrations of DON in the effluent (termed EON) remain relatively high. It was hypothesized that the persistence of EON during treatment is a function of it being refractory. If EON is refractory, its release would not contribute to coastal eutrophication and a case could be made that EON should not be included in WWTP N release budgets. We have been working with local WWTPs to determine if EON is bioavailable, how EON composition changes throughout the BNR process and what affect UV light has on altering the composition and concentration of EON. To investigate the lability of EON, we performed a number of different assays with a suite of effluents to determine whether EON is available to phytoplankton and bacteria either through direct uptake, photochemical release or salinity-mediated release. We found that a significant fraction of EON is bioavailable and should be included in N release limits. Ultra high resolution mass spectrometry was used to chemically characterize the EON at different stages of treatment process to investigate whether EON passes through the plant unchanged or is formed within the plant. We found that a significant portion of EON was produced during the BNR process and that a portion of EON could be broken down with UV light. Our work helps point plant operators towards possible ways of removing the fraction of EON that is labile, reducing downstream eutrophication.

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RT-PCR AS A TOOL FOR MICROBIAL SOURCE TRACKING IN COASTAL CONNECTICUT

Elevated bacterial counts in recreational and fishing waters is a significant water quality issue having environmental, public health, and economic ramifications for Connecticut beaches. Due to shortcomings in traditional methods for detecting and quantifying the presence of these indicator bacteria in waters, new methodologies are being explored with special attention given to methodologies that have the ability to identify sources of contamination. Identification of the sources of bacteria to a species level is an important first step to locating the specific origin of the bacteria, and provides important information for both public health and regulatory purposes. In this study, Real-Time Polymerase Chain Reaction (RT-PCR) was used to detect host specific genetic markers capable of distinguishing between human and non-human sources of contamination. These markers were first tested for their sensitivity and specificity to human waste before applying the methodology to sites in East Haven, and Branford that experienced various levels of contamination. Although RT-PCR makes it possible to quantify the presence of the markers, this study focused on detecting the presence of the markers, rather than giving absolute values of the number of copies present. This qualitative information provides important baseline information for further studies by indicating beaches to target for more in-depth tracking procedures to detect and correct these human sources impacting the contaminated waters.

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REDEFINING SALINITY REGIMES FOR WETLAND VEGETATION ALONG THE NORTHERN GULF OF MEXICO

It has been extensively documented that the species composition in coastal marshes reflects the salinity ecotone from seawater dominated saline marshes to river and run-off dominated fresh water marshes. Along the northern Gulf of Mexico coastal zone, the realized distribution of herbaceous plants along the salinity gradient was first described by Chabreck...
in 1972, and was based on surface water measurements taken during coast wide vegetation surveys in the late summer of 1968. Currently, the Coastal2Reference Monitoring System (CRMS) provides hourly salinity measurements and annual vegetation surveys at 392 stations randomly distributed across the Louisiana coastal zone. This provides an opportunity to describe the realized distribution of the coastal marsh species in greater detail. Information on the distribution of coastal marsh plants can support the design of coastal restoration projects and the forecasting of vegetation changes associated with sea-level rise. Here we query the CRMS database for the 40 most dominant species and determine the annual salinity characteristics that best describe the distribution of these major wetland species. This analysis quantifies the environmental salinity conditions of the most common wetland species found in the Louisiana coastal zone using a robust dataset with high spatial and temporal resolution. This information will be valuable to managers and scientists across the Northern Gulf of Mexico in light of expected climate variability. In addition, the results demonstrate a slight departure from previous conceptions of typical salinity regimes for the most common species.

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EPIFAUNAL-BASED PERFORMANCE MEASURES FOR ESTUARINE ECOSYSTEM RESTORATION

Historical descriptions of the fisheries of Biscayne Bay, Florida suggest that a greater diversity and abundance of fishery species associated with mesohaline habitat once occurred in Biscayne Bay (Smith 1896, Siebenaler 1953) before a massive water management project changed the quantity, timing, and distribution of freshwater inflow. An ecological objective of the Comprehensive Everglades Restoration Plan (CERP) is to restore in nearshore South Biscayne Bay the diversity and abundance of fish and invertebrate communities associated with mesohaline habitat. A monitoring and assessment project that is focused on the epifauna is designed to help assess the effectiveness of CERP in meeting this objective. The project’s purpose is to create a baseline characterization of the present-day alongshore epifauna from Shoul Point to Manatee Bay, determine species relationships with salinity, classify species based on salinity relationships, identify indicators, and formulate performance measures and targets for assessing the effect of CERP. Various ecological indicators and performance measures are being evaluated for potential use to assess the future system-wide and project-level performance of CERP. One index being explored is an integrated faunal-weighted salinity index to quantify the change in faunal community composition and faunal distribution in relation to change in salinity patterns associated with CERP implementation. This and other potential indices will be presented with estimates of their power and implications in terms of sampling design and duration.

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EFFECTS OF CLIMATE CHANGE ON TEMPERATURE AND SALINITY IN THE YAQUINA ESTUARY, OREGON (USA)

As part of a larger study to examine the effect of climate change on estuarine resources, we simulated the effect of rising sea level, changes in river discharge, and increasing atmospheric temperatures on water properties in estuaries along the Pacific coast of the United States. Due to uncertainty in the effects of climate change, model simulations were performed for the Yaquina Estuary, Oregon (USA) for different steady river discharge rates that span the historical range in inflow, and for a range of increases in sea level and atmospheric temperature. Model simulations suggest that in the central portion of the estuary (19 km from mouth), a 60-cm increase in sea level will result in a 2-3 psu change in salinity across a broad range of river discharges. For the oligohaline portion of the estuary, salinity increases associated with a rise in sea level of 60 cm are only apparent at low river discharge rates (< 50 m³ s⁻¹). Simulations suggest that dry season water temperatures near the mouth of the estuary will decrease due to rising sea level advecting cool ocean water into the estuary, while water temperatures in upriver portions of the estuary will increase due to rising atmospheric temperatures and freshwater inflow. Results demonstrate how the interaction of changes in river discharge, rising sea level, and atmospheric temperature associated with climate change produce non-linear patterns in the response of estuarine salinity and temperature, which vary with location inside the estuary and season. We also discuss the importance of presenting results that incorporate uncertainty in climate projections, as well as relating changes in water properties to distribution of estuarine resources and biotic thresholds.

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WAVE IMPACT ON 3D CIRCULATION AND STRATIFICATION WITHIN A MACROTIDAL ESTUARINE SYSTEM

The Dee Estuary, NW English – Welsh border, is major asset, supporting: one of the largest wildlife habitats in Europe, industrial importance along the Welsh coastline, and residential and recreational usage along the English coast. Man-made intervention, e.g. canalization, has led to the siltation of the estuary causing extensive saltmarsh growth along the English coast. To understand the sediment dynamics within the estuary the 3D circulation requires improved understanding. Using cruise data obtained in February – March 2008, a 3D modeling system has been setup to investigate the wave-current-stratification interaction within the estuary under full atmospheric, tidal and riverine forcing. The system consists of a coupled hydrodynamic-wave-turbulence model (POLCOMS-WAM-GOTM) and is validated against in situ salinity, velocity, elevation and wave observation. Waves enhance sediment transport through increased bottom stress and can modify the residual transport pathway due to wave-induced currents. A significant wave event (Ws ~5 m offshore) and a low wave period (Ws < 1.5 m offshore), are used here to determine: (i) the importance wave-tide interaction in determining the spatial distribution of wave activity, (ii) the importance of considering a 3D rather than 2D current field in the wave model, and (iii) the impact of the wave mixing and wave-induced currents on the 3D circulation. The state of the tide at maximum wave impact is found to be very important in determining the spatial wave influence as it controls the water depth. Waves are found to have little impact on the long-term change in the estuary, having significant influence in the short-term. Under storm conditions, the waves can increase the surge levels by up to 6 m, and change the vertical residual current profile due to increase turbulent modifying the stratified structure.

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EMERGY VALUES OF ESTUARINE ECOSYSTEMS: ENVIRONMENTAL ACCOUNTING FOR RECOVERY OF ECOSYSTEM VALUES AFTER DISASTERS

In this presentation we explain an environmental accounting methodology that is based on the scientifically derived measure termed EMERGY. The procedure relays on evaluating natural capital, environmental services and economic good and services without resorting to human preferences or utility, but instead, based on the environmental and economic work necessary to make them. Results from an emergy accounting can be used in conjunction with more traditional economic analysis to provide a multifaceted approach to decision making. To demonstrate the accounting technique, we use the Exxon Valdez Oil Spill in Alaska and the DeepWater Horizon oil leak in the Gulf of Mexico. The total environmental damages from the Exxon Valdez spill were estimated at approximately $1.2 billion dollars ($2 billion today) while the economic costs to Exxon (cleanup costs and payments for lost wages and fishing income) were estimated at $3 billion ($4.8 today). Or, in other words, the value of the environmental damages at the time, was about 42% of the estimated economic losses. We then compare these environmental damages to the estimated environmental damages that would occur as a result double hulking tanker fleets to avoid spills in the future, taking into account the fact that oil spills like many other disasters have a given probability of occurring with a given probability of volume spilled. We conclude that double hulking barely had a positive benefit-cost ratio, but that other modifications that included safety measures and better disaster response had benefit cost ratios that were as high as 2.1. While the data on the DeepWater Horizon disaster are still not available and given all the complexities involved, the total loss of environmental services from the Deepwater Horizon leak are difficult to project, especially since even the amount of oil is disputed. However our first rather tentative estimates of environmental damages could total close to $5 billion.

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ELUCIDATING THE IMPACTS OF HYPOXIA ON THE ACTIVE MICROBES THAT DRIVE NITROGEN FIXATION AND DENITRIFICATION IN ESTUARINE SEDIMENTS

Microbial communities that drive nitrogen (N) cycling in estuarine sediments are extremely diverse making it difficult to identify the functional groups and elucidate controls on their activity. To target the microbes that are the most likely players contributing to the balance of N inputs via N fixation and N outputs via denitrification in the benthic sediments in the estuary Narragansett Bay (RI, USA), we are following the expression of functional genes for N fixation (nifH) and denitrification (nitS). Bay sediments were recently shown to exhibit a seasonal switch in N cycling with high rates of net N fixation. We identified sequences from organisms that express the nifH gene in Bay sediments as relatives of Pelobacter carbinolicus and Desulfovibrio vulgaris, anaerobes that can reduce nitrate and sulfide compounds, respectively. Even with the increase in N loading in estuaries, both
biogeochemically and molecularly we have seen a shift in the N cycle paradigm. Some areas of the Bay exhibit seasonal hypoxia due to the nutrient loading, so we wanted to determine the impact of changing oxygen profiles spatially and temporally on these important anaerobic N fixers. Following the microbes related to sulfur reducers we have detected the presence of nitrogen-fixing bacteria in the surface sediments near a wastewater treatment plant, not a N limited environment. We hypothesize that N fixation in these bacteria is not sensitive to combined N and that the evolution of H2S from the reduction of sulfur inhibits nitrification in the coupled nitrification-denitrification pathway. This feedback then expands the niche for sulfur and sulfate reducers to thrive. N fixing capabilities has not been well studied in these microbes and we are currently cultivating them to learn more about controls on their activity. Combining laboratory and field measurements of gene expression may provide insight into how these microbes react to and in turn influence conditions in their environment.

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CHANGING EDGES: HOW THEY CAN INFORM US ABOUT THE CAUSES OF SALT MARSH LOSS

Salt marshes are being lost on the Atlantic Coast of North America, and potential anthropogenic and natural impacts on salt marshes are varied. Changes in salt marshes are measured in various ways, such as: changes in species composition, changes in food web dynamics, connectivity between plants, and changes in marsh area. This study takes a different approach by looking at the spatial and temporal pattern of edge changes on a Spartina alterniflora marsh. Located in a highly urbanized estuary on the South Shore of Long Island, New York, the focus estuary contains roughly 2,700 hectares of Spartina marsh. Using twelve sets of aerial photographs and GIS software, changes over an eighty one year period were measured at over four hundred randomly chosen points along the marsh edges. It is argued that looking at the changes at specific points along edges is highly informative because each point is exposed to a unique combination of potentially causative influences. This study explores the varied changes seen, even at different edges of the same marsh island, and draws conclusions about the patterns formed by the mix of causes and responses within this estuary. Changes measured at these salt marsh edges were not attributable to any single influence. It was found that edges formed artificially continue to show high rates of loss long after initial damage. Anthropogenic factors include distance to borrow pits and heavy boat usage close to marsh edges. Significant natural influences include unobstructed distance across water and tidal flow rate. Natural forces associated with losses were also associated with small gains, and may indicate sediment redistribution. A gradient in nutrient loading did not reveal either loss or gain resulting from this anthropogenic influence. Other factors will also be discussed. In general, the edges most sheltered from both natural and anthropogenic disturbance have changed relatively little.

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APPLICATION OF THE COASTAL AND MARINE ECOLOGICAL CLASSIFICATION STANDARD (CMECS) SURFACE GEOLOGY COMPONENT (SGC) TO CHESAPEAKE BAY SEABED MAPPING ACTIVITIES

The NOAA Chesapeake Bay Office (NOAA) and the Maryland Geological Survey (MGS) use acoustic mapping systems to chart the distribution of surficial materials and characterize benthic habitats. The primary objective is to identify the spatial extent and condition of oyster habitats, establish optimal locations for oyster restoration projects, and detect reclaimable shell resources. Habitat classification methods varied between the two agencies largely due to different project objectives, limiting the utility of aggregated habitat data. In early 2011 NOAA and MGS collaborated to create a version of the SGC for classification of ocean shell habitats in the Chesapeake Bay. The current rendition contains 37 habitat categories defined by 8 hierarchical attributes. The SGC Subclass “Mollusc Reef” describes 19 natural and artificial oyster shell habitats. Reef morphology descriptors for oyster habitats are modeled on SGC coral and non-coral reef morphologies. The SGC Class “Unconsolidated Substrates” describes 13 habitat categories. We incorporated CMECS into a classification scheme that is integrated into the ArcGIS Habitat Digitizer Extension. It is used to create boundaries around habitat features identified from acoustic backscatter, single beam acoustic classification, video, and grab sample data. In addition to using CMECS to classify the results of current surveys, we forced spatial data from large scale sediment and early oyster shell surveys, dating back to the 1970’s, into the classification scheme. The combination of habitat polygons classified with CMECS derived from multiple historic and current survey extents covers 826 sq km or approximately 73% of the Chesapeake Bay benthos.

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RESTORATION OF OYSTER REEFS AND CLAM POPULATIONS IS A PROVISIONAL CONSERVATION STRATEGY FOR THE CHESAPEAKE BAY

Restoration of oyster reefs and clam populations is a conservation strategy for The Nature Conservancy and numerous other private organizations with marine and estuarine conservation missions. It is increasingly a priority for public management agencies responsible for ensuring the long-term sustainability both of fisheries production and overall environmental health. Measuring the ecological performance of such projects remains a significant challenge, particularly when attempting to discern ecosystem functions that are readily apparent in the laboratory but more challenging to measure and quantify in the field. Significant seston removal rates have been demonstrated using in situ fluorometry (sensu Grizzle et al. 2008) as water flows across oyster reefs and clam beds. To determine whether this translates into higher rates of light penetration on or around reefs, which would benefit sea grasses and other macrophytes, we deployed arrays of Onset HOBO® light- and temperature sensors in 2009 to quantify differences in the ambient light field at fixed depths above and adjacent to restored oyster reefs in Florida and Virginia, and above and around clam beds in Great South Bay, New York. In each location, sensor arrays recorded light intensity (lux) and water temperature at 5-second intervals for approximately 24 hours, sufficient to measure light intensity during each stage of a tidal cycle (ebb, flood, and slack high tide) and daytime hours. While no clear pattern of light-field enhancement was evident using this sampling approach, the data suggest that processes such as sediment resuspension and turbulent mixing may affect light levels, and likely occur at various spatial and temporal scales as water flows across bivalve reefs. Light sensors may still provide a low cost method for gross characterization of restoration projects, provided that the correct sampling interval and spacing of sensors is taken into consideration.

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EVALUATING GROWTH POTENTIAL, ABUNDANCE, AND CONDITION OF WHITE PERCH (MORONE AMERICANA) AS A MEANS TO LINK LAND-USE TO FISH CONDITION IN THREE CHESAPEAKE BAY WATERSHEDS

Understanding the link between anthropogenic influences and water and habitat quality in aquatic ecosystems is imperative for natural resource managers. However, little is known about these impacts on a large ecosystem scale. To evaluate anthropogenic impacts and explore the links between them and aquatic ecosystem health, we conducted an ecosystem assessment of three small Chesapeake Bay watersheds with divergent land use characteristics (agricultural, developed, mixed). Population abundance, weight-length measurements, and white muscle samples for growth potential measurements were collected from adult white perch in all three systems in the summer and fall of 2007-2009 (n = 648). Abundance and weight-length measurements were determined from fish caught by trawls at random locations throughout each system. A microplate assay was developed to determine growth potential using RNA/DNA ratios. The agriculturally dominated system supported a greater abundance and diversity of fish than the other systems examined (p < 0.001). However, RNA/DNA ratios and relative weight (Wr) values were consistently lower than the other watersheds in all seasons (p < 0.05). Our results suggest density dependent factors influence growth characteristics of adult fish in a nutrient rich, highly productive, agricultural influenced system when compared to more urban or mixed-use watersheds. Additionally, although RNA/DNA ratios and Wr provided similar information, the relationship between the two was poor within individual fish.
These are compared to the nutrient breakpoints to gauge the extent to which nutrient concentrations under full implementation of the Chesapeake Bay TMDL were detected only after the confounding effects of other factors are removed. Estimates of local or breakpoints above which biotic condition deteriorates. Breakpoints were typically Regression Tree (CART) and a “binning” approach, were used to identify nutrient thresholds. Rivers were recently explored for Maryland and the results are used to begin informing this periphyton and macroinvertebrate nutrient responses in Chesapeake’s non-tidal streams and robustness. Are the projected nitrogen and phosphorus reductions in the Bay’s rivers too TO CHESAPEAKE BAY’S NUTRIENT DIET POSSIBLE RESPONSES OF NON-TIDAL STREAM AND RIVER COMMUNITIES TO CHESAPEAKE BAY’S NUTRIENT DIET

The “nutrient diet” prescribed in Total Maximum Daily Loads (TMDL) agreements for Chesapeake Bay is intended to help the estuary recover its former ecological productivity and robustness. Are the projected nitrogen and phosphorus reductions in the Bay’s rivers too large, too small or just right to also benefit upstream aquatic communities? Phytoplankton, periphyton and macroinvertebrate nutrient responses in Chesapeake’s non-tidal streams and rivers were recently explored for Maryland and the results are used to begin informing this Goldilocks question. Data collected since the 1980s by local, state and federal agencies in the Bay region were assembled and analyzed. Several methods, including Category and Regression Tree (CART) and a “binning” approach, were used to identify nutrient thresholds or breakpoints above which biotic condition deteriorates. Breakpoints were typically detected only after the confounding effects of other factors are removed. Estimates of local nutrient concentrations under full implementation of the Chesapeake Bay TMDL were developed by the Chesapeake Bay Program for streams and rivers in the Bay watershed. These are compared to the nutrient breakpoints to gauge the extent to which nutrient reductions under the Chesapeake Bay TMDL help protect local water quality.

POSSIBLE RESPONSES OF NON-TIDAL STREAM AND RIVER COMMUNITIES TO CHESAPEAKE BAY’S NUTRIENT DIET

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THE INFLUENCE OF MARINE NUTRIENTS ON PHYTOPLANKTON BLOOMS IN A LOW-INFLOW ESTUARY

Drakes Estero, located in Point Reyes National Seashore, CA, is a shallow low-inflow estuary where harmful algal bloom (HAB) species including Alexandrium catenella have been observed. Nutrient supply to the estero is primarily via tidal influxes from the adjacent ocean, which is an important wind-driven coastal upwelling region. Additional terrestrial nutrients delivered through land runoff from wilderness areas and cattle grazing lands are likely important in winter. The estero is also the site of an oyster aquaculture facility, which may enhance local sources of regenerated nutrients. At present, the influence of nutrient supply from these varied sources on phytoplankton communities and primary production is unknown. We hypothesize that seasonal shifts in nutrient sources and levels drive seasonal variation in primary production and shifts in dominant phytoplankton species, including HAB dinoflagellates. A study was initiated in May 2010 to measure seasonal and spatial variations in nutrient concentrations, chlorophyll, and primary production and nitrogen uptake as well as to enumerate phytoplankton species. During the low-inflow estuarine season (July-October) a gradient in nutrient concentrations and elemental ratios was observed along the land-to-sea axis of the estero with the landward region exhibiting elevated ammonium and low DIN : PON, compared to the coastal location that had elevated levels of nitrate and high DIN : PON ratio. Phytoplankton blooms were observed at the coastal and middle estero locations, dominated by diatoms during the upwelling season and dinoflagellates during the fall. This study will provide water resource managers with a mechanistic look at the consequences of different nitrogen sources and the influence of coastal upwelling on the phytoplankton community and ecology of Drakes Estero.

PEER REVIEWS OF THE ECOLOGICAL AND HUMAN HEALTH AND SAFETY ASPECTS OF THE MARINE NUTRIENT DISCHARGE IN THE CHESAPEAKE BAY, USA

The “nutrient diet” prescribed in Total Maximum Daily Loads (TMDL) agreements for Chesapeake Bay is intended to help the estuary recover its former ecological productivity and robustness. Are the projected nitrogen and phosphorus reductions in the Bay’s rivers too large, too small or just right to also benefit upstream aquatic communities? Phytoplankton, periphyton and macroinvertebrate nutrient responses in Chesapeake’s non-tidal streams and rivers were recently explored for Maryland and the results are used to begin informing this Goldilocks question. Data collected since the 1980s by local, state and federal agencies in the Bay region were assembled and analyzed. Several methods, including Category and Regression Tree (CART) and a “binning” approach, were used to identify nutrient thresholds or breakpoints above which biotic condition deteriorates. Breakpoints were typically detected only after the confounding effects of other factors are removed. Estimates of local nutrient concentrations under full implementation of the Chesapeake Bay TMDL were developed by the Chesapeake Bay Program for streams and rivers in the Bay watershed. These are compared to the nutrient breakpoints to gauge the extent to which nutrient reductions under the Chesapeake Bay TMDL help protect local water quality.

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HYPNOXIA EFFECTS ON THE COMPOSITION OF BOTTOM FAUNA COMMUNITIES (HYPERBENTHOS AND INFANFA) IN FJORDS ON THE NORWEGIAN SKAGERRAK COAST

At present there is a need for ecological quality criteria in environmental management of marine benthos. Early warning of environmental degradation is essential and identification of sensitive indicator-organisms is therefore crucial. Benthic studies have traditionally focused on infauna and consequently species indicative of eutrophication has been sought in this fauna. However, the mobile fauna living at the sediment-water interface 'hyperbenthos' is assumed to be particularly sensitive to hypoxia. Unfortunately, little information is available on the response of this fauna. Unique long-time series of oxygen measurements exists for many fjord-basins along the Norwegian Skagerrak coast. These long-time measurements provide an opportunity to study the fauna in fjords with a known oxygen history. We will present results from a 3 year project that has investigated the hyperbenthos and macro-infauna in 11 fjord-basins representing a gradient in eutrophication-related hypoxia. Fauna and sediment was collected from the deepest part of the fjords. Hyperbenthos was collected with an epibenthic sledge and infauna was sampled using grab. Sediment samples were analyzed for: grain size, water content, carbon, nitrogen, chlorophyll a, and Feopigments, and redox measurements were taken. Bottom fauna diversity was strongest correlated with oxygen minimum during the last 5 years. Correlation between species richness of hyperbenthos and oxygen minimum was very strong (R2 = 0.91) and amphipods, isopods and copepods were the most vulnerable groups. Also infauna showed a clear response to oxygen minimum (R2 = 0.81) with molluscs as the most sensitive group. The relation between minimum oxygen concentration and species richness was used to estimate loss of species based on decrease in oxygen over time. Estimated species-loss in the 11 fjords indicates that many of the fjords on the Skagerrak coast have lost 50% or more of their bottom-fauna species due to eutrophication since 1980.

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SEASONAL GROWTH AND EXPANSION OF NATIVE AND NON-NATIVE EELGRASSES ON AN INTERTIDAL FLAT IN THE PACIFIC NORTHWEST

The native eelgrass, Zostera marina, grows on extensive intertidal and subtidal flats in Padilla Bay, Washington covering more than 3000 hectares. The non-native eelgrass, Z. japonica, was accidently introduced to the Pacific Northwest with the importation and culture of Pacific Oysters in the mid-1900s. Z. japonica initially became established in Padilla Bay on intertidal flats that had been bare of macro-vegetation. Increasingly, the two species are growing intermixed. The seasonal pattern of growth was measured in fixed plots and showed a clear response to oxygen minimum (R2 = 0.81) with molluscs as the most sensitive group. The relation between minimum oxygen concentration and species richness was used to estimate loss of species based on decrease in oxygen over time. Estimated species-loss in the 11 fjords indicates that many of the fjords on the Skagerrak coast have lost 50% or more of their bottom-fauna species due to eutrophication since 1980.

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TOP-DOWN CONTROL IN A RELATIVELY PRISTINE SEAGRASS ECOSYSTEM

Coastal marine ecosystems have been degraded dramatically worldwide and continue to be threatened. Seagrass ecosystems, which provide critical habitat for juveniles of many species, including commercially important ones, have been particularly hard-hit. Of particular interest is the loss of large herbivores (e.g. sea turtles and sirenians) and top predators (e.g. sharks), which may have disrupted top-down processes that were historically important. We used exclusion cages to elucidate the effects of large herbivores (green sea turtles, Chelonia mydas and dugongs, Dugong dugon) on seagrass community structure, nutrient dynamics, and ecosystem dynamics in the relatively pristine seagrass ecosystem of Shark Bay, Western Australia. We also investigated the possible indirect effect of top predators (tiger sharks, Galeocerdo cuvier) on seagrass beds mediated by spatiotemporal shifts in grazing by green turtles and dugongs. Excluding large grazers from mixed beds of Halodule univirnes, Cymodocea angustata, and Halophila ovalis for thirty-two months resulted in a shift in seagrass community composition, increased shoot lengths in all species and increased total seagrass biomass. However, responses to exclusions were species-specific. There were increases in percent cover and shoot density for Cymodocea angustata but a decrease in cover and density for both Halodule univirnes and Halophila ovalis. Overall, our findings suggest that spatiotemporal shifts in foraging habitat use by megazgrazers may mediate indirect effects of tiger sharks on the seagrass communities of
Societies, Estuaries & Coasts: Adapting to Change

Abstract Book

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THE NITROGEN BUDGET IN COASTAL WATERS OF THE NORTHERN GULF OF MEXICO IS INFLUENCED BY SEASONAL HYPOXIC EVENTS

Coastal zones, such as the Mississippi Bight in the Northern Gulf of Mexico, represent a unique transition between atmosphere, land and ocean with strong physical and biogeochemical couplings. One of the key processes in the biogeochemical nitrogen (N) cycle in this environment is anthropogenic nutrient loading, autotrophic nutrient acquisition and microbial regeneration of elemental nutrients. A seasonal hypoxia has been observed in summer in the NW part of the Mississippi Bight during the last 3 years. The severity of the hypoxia appears to be determined by organic loading of the benthos and strength of water column stratification. A three year time-series of the dissolved inorganic nitrogen (DIN) and phosphate (DIP) distribution in the Mississippi Bight shows a distinct temporal and spatial pattern. Whereas the ratio between DIN and DIP nutrients (the dissolved N:P ratio) appears to decline as a function of distance from shore, seasonal hypoxia may further exhaust the loss of elemental N from the water column. During periods of hypoxia, the water column N-cycle mediated by microorganisms sees a shift towards higher N2 production through aerobic ammonium oxidation (anammox) and denitrification. The only source of fixed N to the water column in offshore waters is by microbial assimilation of N2 and this is done by diazotrophic (N2-fixing) cyanobacteria. Here we report the seasonal significance of diazotrophy, heterotrophic denitrification and ammanox using molecular tools and specific 15N-labelling experiments. The water column nitrogen budget is discussed and compared to rates of N2 fixation and losses caused by denitrification and anammox.

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BREATHELESS NIGHTS: DIEL-CYCLING HYPOXIA AND THE PREVALENCE OF PERKINS US MARINUS (DERMO) INFECTIONS IN CRASSOSTREA VIRGINICA

Spatial variation in the physical environment potentially influences disease processes through differential effects on pathogens and their hosts. Persistent exposure to hypoxia at levels higher than those known to cause mortality of uninfected oysters increases mortality of oysters infected with Perkinsus marinus (Dermo). However, little is known about the consequences of chronic exposure to diel-cycling hypoxia that is common in nutrient enriched shallow waters, and is characterized by dissolved oxygen concentrations that vary from supersaturated during mid-day to between zero and about 50% saturation in early morning hours. We used laboratory and field experiments to examine the relationship between diel-cycling hypoxia and the acquisition and progression of P. marinus infections in Crassostrea virginica. One-year-old initially uninfected oysters were used to test for infection acquisition, and 2-3 yr-old oysters that initially had a high prevalence of low to moderate intensity infections served as both a source of infection for younger oysters and as a test of the effect of hypoxia on disease progression. Both laboratory and field experiments indicated that diel-cycling hypoxia increases acquisition of P. marinus infections by previously uninfected oysters, most likely by reducing immune responses. Diel-cycling hypoxia also increased progression of infections in the field and decreased growth rates in both the lab and field studies. Our experiments suggest that diel-cycling hypoxia can create spatial variation in disease dynamics and is important to consider in restoration siting. Experiments being conducted during 2011 include manipulations of pH as well as dissolved oxygen.

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STATUS OF THE DELAWARE ESTUARY LIVING SHORELINE INITIATIVE (DELSI)

The DELSI project was initiated in 2007 to bring rapidly evolving living shoreline strategies to the Delaware Estuary as an alternative to more traditional bulkheads and rock revetments. An innovative tactic was to investigate the incorporation of naturally dissipative aggregations of ribbed mussels (Geukensia demissa) into the design. Coconut fiber (coir) logs and mats were used to stabilize and trap sediments at several sites spanning a gradient of erosional forces and energy. Oyster shell bags were used at the leading edge to prevent undercutting. These structures were then seeded with Spatina alterniflora plugs as well as ribbed mussels. Installations trapped sediments quickly at all sites, but failed at higher energy sites that were either exposed to a large fetch or excessive boat wakes. Treatments in lower energy areas survived well and tolerated relatively heavy ice flows during winter. Maintaining correct elevations proved critical in the survival and persistence of Spatina plantings. Mussels transplanted from nearby populations and seeded into logs quickly attached to stabilize the degrading coir log, but there is a need to develop methods to produce mussel seed. Seining and trapping found 18 of 20 species that were used to flood marsh shorelines were present in the created living shorelines at similar abundances and biomass. Increased nekton usage by baitfish and juvenile sport fish was particularly striking after converting rip-rap to fringing marsh habitat indicating this is a valuable method to improve and enhance fish habitats. Funding from Dupont is allowing us to explore methods to produce ribbed mussels and develop a ribbed mussel gardening program. Permitting remains a major impediment, but headway is being made as state regulators see the ground efforts and begin to understand what comprises a living shoreline and the benefits it can provide.

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FEAST OR FAME FOR FRESHWATER INFLOWS TO THE MISSION-ARANAS ESTUARY: IMPACTS ON NUTRIENTS, PLANKTON POPULATIONS AND NET ECOSYSTEM METABOLISM

The Mission-Aranas estuary of south Texas alternates between major freshwater inflow events that deliver nutrients to the ecosystem and stimulate plankton populations, and periods of extended drought which can drastically reduce freshwater inflow. In 2007 four permanent hydrographic monitoring stations were installed along a salinity gradient from the freshwater inflow of the Aransas River to the seawater exchange pass to the open Gulf of Mexico. Monthly sampling programs were also begun to measure nutrients and monitor plankton populations. Major freshwater inflow events were observed in 2007 and 2009, which alternated with extended periods of drought. Freshwater inflow events were found to correspond with shifts in nutrient concentrations and ratios, plankton biomass, plankton species diversity and net ecosystem metabolism. These relationships have important implications for efforts to determine the pattern and amount of freshwater inflows needed to maintain ecosystem function and productivity in semi-arid coastal regions with increasing demand for freshwater resources. In Texas, salinity distributions and their effects on biota have been the main criteria used for determining environmental flows to coastal estuaries; nutrients and the plankton productivity they stimulate have not been considered.

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Control of nitrogen loading to reduce eutrophication in Chesapeake Bay has been an issue for several decades. A major input of nitrogen to the Bay is from the Susquehanna River, and oxidized atmospheric inputs represent 20% to 25% of the estimated net anthropogenic nitrogen input to the watershed, which is strongly correlated to the nitrogen discharge of the Susquehanna to Chesapeake Bay. While many of the atmospheric inputs (NO3- and NH4+ from wet deposition, particulate NO3- and NH4+ and gaseous HNO3 from dry deposition) are reasonably well-understood, other atmospheric nitrogen sources (wet-organic nitrogen and dry deposition of NOx and NH3) are not empirically well quantified. Gaseous ammonia deposition may be a significant component of total N deposition particularly in and near areas of agricultural activity. Using passive samplers we have measured concentrations of NH3 and NO2 in a number of landscapes representing land use areas found in the upper Susquehanna Watershed such as agricultural farmland, animal production facilities, forests, roadsides and urban areas. Using representative deposition velocities we have estimated the contribution of NO2 and NH3 to total deposition. Our results show that for most landscapes NH3 deposition can account for a significant percentage of the total nitrogen deposition to the the upper Susquehanna watershed. NO2 deposition is less important, except near roadsides where NO2 and NH3 deposition are comparable. We will present data on concentration and deposition of these species and their relative importance compared to other nitrogen deposition species. These deposition results will be compared with estimates of deposition generated by the EPA CMAQ model for this region. Control of both NOx (mainly from vehicle and utility emissions) and NH3 (mainly from agriculture and livestock production) will further reduce nitrogen loading from the upper Susquehanna watershed to Chesapeake Bay ecosystem.

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SOURCES OF ATMOSPHERIC NITROGEN TO THE UPPER SUSQUEHANNA RIVER: CHESAPEAKE BAY WATERSHED WITH SPECIAL REFERENCE TO AMMONIA

Long-term reductions in freshwater delivery to Apalachicola Bay, Florida, threaten its biological integrity and ability to support commercially-important fisheries. Changes in river flow are expected to cause shifts in the spatial structure of estuarine phytoplankton populations, which could have cascading effects on higher trophic levels such as commercially-important oysters. To better predict how flow-induced changes may affect Apalachicola Bay ecosystem dynamics, we mapped the spatial distribution of phytoplankton in response to varying freshwater input at orders-of-magnitude finer resolution than has been previously recorded. Geo-oriented measurements were collected at 50 m resolution throughout Apalachicola Bay every two weeks beginning in May 2009. To supplement this high spatial resolution data, discrete samples were collected to measure nutrients, particulate organic matter, and phytoplankton taxonomic composition/biomass. High-resolution temporal data was also obtained from in situ chlorophyll and water quality sensors deployed at a major oyster reef. Results of statistical and geospatial analyses will be presented and will allow for better understanding of the effects of river flow and water properties on phytoplankton community characteristics.

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HYDRODYNAMICS OF MOSQUITO LAGOON, FLORIDA

Mosquito Lagoon is a shallow (average 1 m deep), long (50 km), and narrow (5 km) body of water on the Florida Atlantic coast. The lagoon is connected to the Atlantic Ocean via Ponce Inlet from the north and the Indian River Lagoon by Haulover Canal from the south. Islands, oyster bars, shoals, and roads redirect flow and isolate smaller flats, creeks, and other bodies of water within the lagoon into micro ecosystems. The hydrodynamics of Mosquito Lagoon have not yet been described in detail, and understanding how these ecosystems relate to one another is critical for understanding the overall water-quantity conditions in the lagoon. Precipitation and evaporation data from Banana River, an estuary on the southern border of Mosquito Lagoon, was used to explain the salinity variability (r2 = 0.61). Recent measurements in Mosquito Lagoon (unpublished data) suggest a strong correlation between precipitation and evaporation to salinity characteristics in this body of water. Surface-water salinity and temperature were measured from a boat on 5/3/2010 from the outlet of Haulover Canal to Ponce Inlet. Additional measurements were made from a kayak on 5/11/2010, 3/24/2011, and 5/5/2011. The surveys via kayak covered hard to reach shallow areas in depths ranging from 0.2 to 1 m. Salinity values recorded during each survey were similar, ranging from 27 to 43 ppt. It is believed that the prevailing predictive parameters for salinity in the lagoon are precipitation and evaporation. Future research will focus on describing the salinity characteristics of Mosquito Lagoon using precipitation and evaporation data. One specific area of interest is a series of canals with substantially lower salinity than the neighboring lagoon where discharging groundwater may be used to explain these conditions.

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RESTORING PROPELLER DAMAGE IN SEAGRASS MEADOWS OF THE NORTHERN GULF COAST: DO BIRD ROOSTS AS PASSIVE FERTILIZER DELIVERY SYSTEMS WORK?

Global seagrass decline has become more widely documented in the past few decades with most of the focus on declining water quality as the cause. An additional and increasing threat to these shallow water macrophytes is the rise in recreational use of nearshore shallow habitats. Increased boating activity has resulted in increased mechanical damage to seagrass beds from propeller scars, anchor scars and groundings. If left untreated, recovery after such damage can take anywhere between 1.5 to 3.5 years. To address this problem, we have developed a novel method using seabird roosts as passive fertilizer delivery systems to stimulate seagrass recovery after mechanical damage. The method involves providing bats with artificial roosting structures in areas where seagrass is damaged. The bats are attracted to the roosts and deposit their excreta, which is rich in nitrogen and phosphorus, on the seagrass beds. This fertilization promotes seagrass growth and helps to restore damaged areas. The method is cost-effective, environmentally friendly, and can be implemented in areas with high bat populations. The results of this study have shown promising outcomes, indicating the potential of using bird roosts as an effective and sustainable method for seagrass restoration.
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GROUNDSWATER FLOW ALONG THE LOUISIANA DELTAIC COAST DRIVEN BY MISSISSIPPI RIVER STAGE?

Groundwater studies in deltaic regions have yielded controversial results over the past 10 to 20 years due to the heterogeneous and anisotropic nature of the sedimentary deposits along these systems. Most numerical modeling studies indicate groundwater flow to deltaic marshes and bays should be low. However, water and salt balances do not agree with these modeling studies and suggest the hydrologic budgets for deltaic bays and bayous are not well known. These budgets generally show a missing freshwater source is required to balance the hydrologic budget. Several hypotheses have been postulated to explain the missing freshwater component, including river discharging at the mouth which wraps back into the bays or arbitrary unknown streams which have been unwittingly left out of the budget. Neither of these explanations is satisfactory, because on the one hand river water is not found to enter coastal bays from the shelf and on the other hand no arbitrary streams can be located. Seasonal Rn-222 water column inventories measured along the axis of Barataria Basin provide further evidence supporting the water and salt balances that a missing freshwater component enters the basin. We find Rn-222 in excess of that which can be supported by sediment diffusion or water column production. Some advective source for Rn-222 must occur – this missing freshwater source is likely from groundwater discharging from buried sandy-bed paleochannels left behind by previous river avulsions. These paleochannels often maintain a subsurface connection with the modern river so that at high river stage the hydraulic gradient between the river and adjacent bay drives groundwater discharge. A qualitative relationship between Rn-222 inventories and river stage supports the vector as a driving force for the hydraulic head difference and groundwater flow, especially in the upper basin region of Barataria.

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USING INUNDATION TIMING TO ESTIMATE FLOW RESISTANCE THROUGH MARSH VEGETATION

For marshes to survive rising sea levels, net surface accretion must be great enough to raise the marsh platform at a similar rate. Flow resistance through marsh vegetation has been shown to be a primary control on flow velocity, turbulence, and sedimentation rates. Resistance, in turn, is controlled in large part by vegetation characteristics such as stem density or biomass within the water column. Thus resistance drives a coupled feedback between vegetation and sediment dynamics that contributes to the resilience of a marsh to rising sea level. The goal of this research is to estimate flow resistance values for various marsh vegetation community structures. Quantifying resistance, however, is challenging, particularly in the low velocities and low energy slopes characteristic of flows in meso-tidal marshes. We explore a new technique that produces spatially integrated resistance values for the up-gradient area contributing flow to a particular point by quantifying the time lag between inundation predicted by elevation and observed inundation. Continuously logging temperature probes are deployed in transects across a marsh surface to identify the moments of inundation and re-exposure to air. These times are compared to tide stage data logged at the edge of the marsh and at the upper end of a tidal creek that feeds the marsh. The delay between the open water tide passing the elevation of the site and the water reaching the site is a measure of the total resistance along the route traveled by the water. Flow depth and velocity are modeled along the transects with the de Saint-Venant equations solved with a finite difference scheme. Modeled inundation times are matched to observed inundation times by varying the Darcy-Weischbach friction factors for the various marsh communities transited by the flow between the marsh edge and the temperature probe site, yielding resistance estimates for these communities.

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RESOLVING DRIVERS OF VARIABILITY IN ESTUARINE METABOLISM FROM SUSTAINED OBSERVATIONS OF WATER QUALITY IN THE SOUTHEASTERN US

Understanding the effect of climate change and other human activities on estuaries is essential to preserve and protect these highly productive and vibrant ecosystems. To that end, we examine trends in water quality data from long-term monitoring (10-15 y) at 5 estuarine systems of NOAA’s National Estuarine Research Reserve System Wide Monitoring Program: Grand Bay, MS; Weeks Bay, AL; Apalachicola Bay, FL; Rookery Bay, FL, and Guana Tolomato and Matanzas Rivers, FL. These estuaries vary in size, flow regime, watershed area, anthropogenic influence, and land use. Water quality variables (temperature, salinity, dissolved oxygen, and pH) were measured with in-situ data sondes at multiple sites in each system. We examine seasonal and interannual patterns in these high frequency water quality data for temporal coherence both within and among the estuaries. Results from preliminary analysis shows strong coherence among all systems in annual salinity anomaly, calculated as the deviation of annual mean salinity from the long term mean, with highest salinity anomalies observed during the droughts of 2000-2002 and 2006-2007. The frequency of hypoxia (DO < 2 mg/L), used as an index of potential eutrophication, occurred infrequently at some sites (<1% per annum) and regularly at others (e.g., up to 17% per annum in Weeks Bay). Dissolved oxygen data are used to calculate daily gross production, respiration and net ecosystem metabolism (NEM) parameters. We hypothesize that warmer temperatures or higher flow regimes will cause a decrease in NEM, since cooler temperatures of lower flow regimes will result in higher NEM. Supporting this hypothesis, prior analyses of Apalachicola and Weeks Bay data showed that gross production decreased during flood periods, likely due to increased turbidity and reduced residence time. Analysis of long term monitoring data can provide insights into the relative importance of anthropogenic and external drivers on estuarine ecosystem function.

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PHYSICAL AND BIOLOGICAL CONTROLS ON INTERTIDAL WETLAND VULNERABILITY TO SEA-LEVEL RISE

Intertidal wetland sustainability depends on maintaining the same relative position to sea level through wetland vertical development as sea level rises. Thus predicting wetland vulnerability to sea-level rise requires improving not only our understanding of future trends in sea-level rise but also the process controls of wetland elevation. This paper reviews our current understanding of the process controls on wetland vertical development from both minerogenic and biogenic processes (e.g., surface sediment deposition and subsurface soil organic matter accumulation) and the influence of environmental drivers (e.g., increases in air and soil temperatures, atmospheric concentrations of CO2, storms, human disturbance and management (i.e., fire), and nutrient enrichment) on these processes. Recent findings show that process controls on wetland vertical development typically vary among marsh types and settings. In addition, some controls are better understood than others and most are changing rapidly as a result of human and climate impacts. For example, elevated atmospheric concentrations of CO2 positively influence root zone dynamics in marshes dominated by C3 but not C4 species, and the CO2 stimulus is turned off by nitrogen enrichment. So vegetation type, geomorphic setting, and water quality can all interact to determine wetland elevation. Thus understanding wetland vertical development requires site-
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SEDIMENT ACCRETION AND CARBON SEQUESTRATION IN SAN FRANCISCO BAY TIDAL WETLANDS

Because of their location at the land-water interface, tidal wetlands will play a critical role in relation to climate change. Sea-level rise will affect the long-term stability of tidal wetlands, depending on the magnitude of future increases in sea level and the ability of individual wetlands to accumulate sediment and keep pace with these changes. In addition, tidal wetlands can influence climate change by accumulating soil carbon. Our research is motivated in part by the need to provide background data to predict long-term rates of carbon sequestration in restored wetlands within the San Francisco Bay Estuary, as California is currently evaluating the possibility of assigning carbon trading credits for wetland restoration. We measured sediment accretion and carbon sequestration rates at six natural salt and brackish tidal wetlands representing the geographical range of the San Francisco Bay Estuary. These sites also serve as analogs for long-term carbon sequestration in restored wetlands. We collected six cores at each natural wetland (two transects with three stations each). This approach allowed us to identify spatial variation both within and among wetlands in the Estuary. Cores from natural wetlands were dated using 14C and 210Pb profiles. Although accretion rates could not be measured at restored wetlands, cores were also collected from two restored wetlands for comparison of soil organic matter and bulk density. Most sites accreted 0.3-0.5 cm yr\(^{-1}\), with slightly higher rates at low marsh stations, indicating that wetlands within the Estuary are keeping pace with current rates of sea-level rise. Carbon sequestration rates averaged approximately 80 g m\(^{-2}\) yr\(^{-1}\) over the 100-year time span of 210Pb and were slightly higher for 137Cs-based rates. Variation in long-term carbon sequestration rates across sites and stations was much smaller than the variation in mineral inputs, with few significant differences in carbon sequestration rates.

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FACTORS CONTROLLING WATER QUALITY AND VERTICAL ACCRETION ON EXPERIMENTAL CONSTRUCTED WETLANDS (EBRO DELTA, SPAIN)

The Ebro Delta (Catalonia, Spain) is one of the most important wetlands in the western Mediterranean, highly valuable both economically and ecologically. Its natural hydrological and sedimentary regimes have been heavily modified by dams and land reclamation leading to coastal erosion and surface elevation loss. The historic and current agricultural and human land use have transformed large areas of wetlands and lagoons into rice fields, which now occupy up to 60% of the deltaic plain. Agricultural runoff carries nutrients, heavy metals and organic pollutants to natural habitats due to pesticide and fertilizer use. To reduce these ecological impacts, several wetland restoration efforts have been initiated seeking to increase vertical accretion, improve water quality and develop wildlife habitat. However, there are few studies looking at the factors controlling water quality and vertical accretion conditions for these wetland restoration initiatives. This study measured how the chemical, hydrological and biological factors controlled water quality and vertical accretion in a experimental constructed wetland receiving drainage water and canal water from the rice irrigation system. The specific objectives were (1) to quantify nutrient uptake and vegetation response as a function of the type of water input and the water level, (2) to measure the impact of these different water inputs and levels on plant productivity and vertical accretion.

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IN SITU CO2 ENRICHMENT: IMPACTS ON A NEARSHORE SEAGRASS COMMUNITY

A novel technique of benthic in situ carbon dioxide enrichment was developed to assess the responses of a shallow seagrass community to increasing dissolved CO2 concentrations. Clear, 'open-top' chambers were utilized to establish three enrichment treatments (elevated CO2 within chambers; ambient CO2 within chambers; and ambient CO2 within unchambered controls). Carbon enrichment was monitored and regulated throughout the experiment using diurnal measurements of pH and total alkalinity within each chamber. Both seagrass responses (stable carbon isotopes, productivity, and soluble sugars) and epiphyte responses (community composition and calcium carbonate load) were monitored periodically. Enriched chambers demonstrated significantly lower pH values and higher CO2 concentrations as compared to the control chambers and plots. The efficacy of CO2 enrichment was further demonstrated by seagrass stable carbon isotope values, with enriched chambers displaying increasingly negative 13C values as compared to the control treatments. Seagrass productivity was not significantly impacted by CO2 enrichment during any sampling date; however seagrass soluble sucrose content was elevated within the enriched chambers. The seagrass epiphyte community was extremely responsive to CO2 enrichment, with the enriched chambers displaying lower abundances of epiphytic calcifiers (crustose coralline algae and polychaete worms) as compared to the control chambers. In addition, CO2 enriched chambers displayed increased abundances of epiphytic filamentous red algae in comparison to the control chambers. Our results demonstrate that seagrass communities may respond to additional CO2 supply by increasing carbohydrate storage within belowground structures. Furthermore, the results of our epiphyte analysis show dramatic responses from a variety of calcifying groups, with implications for future reductions in calcification rates and sediment production within shallow seagrass beds.
EXPLORING THE ROLE OF SILICA LIMITATION IN NUTRIENT-ENRICHED MARSHES

In coastal waters, excess nitrogen (N) and phosphorus (P) in relation to silica (Si) can result in N-limitation. While the effects of excess N and P on salt marsh processes have appropriately received much research attention, this study is the first to assess the impact of these nutrients on Si biogeochemistry. Salt marsh vegetation in New England, particularly S. alterniflora and S. patens, are active Si accumulators. The objective of the research described here is to quantify net Si accumulation in New England salt marshes with respect to N and P availability. This on-going study quantifies and characterizes the net accumulation of Si in two salt marshes in Narragansett Bay, Rhode Island (USA) - a degraded marsh with elevated N and P inputs, and a less-impacted marsh with significantly lower exposure to N and P loading. Here we report net Si accumulation in biomass, sediment, and porewater determined seasonally over a complete growing season (April 2010 to February 2011). The marsh exposed to elevated N and P levels showed higher rates of BSi accumulation compared to the low nutrient marsh. We observed this pattern in all reservoirs of the marsh. For example, summer sediment Si concentrations were significantly higher (p<0.04) in the high nutrient site when compared to the low nutrient site (0.54% and 0.13% SiO2, respectively). We found a similar pattern with marsh porewater dissolved Si concentrations, which were 31% higher at the N and P enriched site (142 uM vs. 104 uM). Tidal creek waters were also four times higher on the ebb and flood tide at the nutrient-enriched site, indicating a close coupling between Si cycling within the marsh and the inundating tidal waters. We hypothesize that this increased Si accumulation at the nutrient-enriched site is due to several mechanisms including increased microbial activity, altered marsh structure, and Si accumulation as a means of protection against environmental stressors.

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SALINITY EFFECTS ON SEDIMENT NITROGEN CYCLING PROCESSES IN THE CAPE FEAR RIVER ESTUARY

Estuarine ecosystems have received substantial and continuous stress from salinity fluctuation due to tidal cycles, climate change, sea level rise, and expanding water resource use. Salinity changes can cause a wide range of physical and chemical effects as ionic strength and chemical composition are altered. As a result of the changes in physical and chemical parameters, sedimentary microbial processes are altered along with microbial community structure. The effects of salinity changes on microbial nitrogen (N) removal (denitrification; DNF and ammonox; AMX) and recycling (nitrification; NTR) processes were examined using a novel design of in situ sediment transplant experiments in the Cape Fear River Estuary (CFRE). Discrete sediment samples collected from oligo-, meso-, and poly-haline sites in the CFRE were placed in membrane sealed packets. Packets from each of the salinity regimes were placed in 3 PVC constructed transplant devices. Placing these 3 devices in the sites where each of the original sediments was collected, each sediment salinity regime, and accompanying microbial community, was exposed to each of the 3 different salinities. Packets from different native salinities were removed from each transplant device at 3, 6 and 9 months. Rates of DNF, AMX, and NTR were measured and compared using 15N tracer incubation and 15N dilution methods. Measurements demonstrate that oligohaline NTR communities are more susceptible to salinity increases than DNF and AMX communities. Both oligo- and polyhaline DNF and AMX rates initially react to salinity changes similarly, but AMX bacteria acclimated to higher salinity are more resilient to changes in salinity than DNF bacteria. Under these circumstances salinity encroachment may reduce NTR recycling while increasing the importance of AMX as a N removal mechanism thus promoting more oligotrophic estuarine ecosystems.

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CHARACTERIZING SPATIAL PATTERN IN DELTAIC WETLAND VEGETATION USING WORLDVIEW-2 MULTISPECTRAL IMAGERY

Freshwater, deltaic wetlands are highly diverse, spatially heterogeneous and seasonally dynamic systems that present unique challenges to remote sensing and spatial analysis. Wax Lake Delta, a naturally evolving delta of the Mississippi River in Atchafalaya Bay, Louisiana and is representative of how deltaic wetlands form and evolve in response to changes in hydrology and sedimentation. We tested species and community-level wetland vegetation classification methods at Wax Lake Delta using 8-band high-resolution imagery from the new WorldView-2 satellite sensor. Both traditional hard and fuzzy supervised classifications were considered. Hard and fuzzy accuracy assessments were performed by comparing a stratified random sample of 742 points in the classified image to reference maps created from visual interpretation of aerial photography and field verification. The wetland vegetation maps that resulted from both the hard and fuzzy classifications accurately captured large-scale trends in vegetation community distribution within Wax Lake Delta. Overall hard classification accuracy was 62 percent for the species level classification, with user’s accuracies ranging from 7 to 97 percent and producer’s accuracies ranging from 42 to 92 percent. The overall accuracy of the community-level classification was 78 percent, with user’s accuracies ranging from 69 to 96 percent and producer’s accuracies ranging from 57 to 98 percent. Fuzzy accuracy was 74 percent for the species-level map. These accuracies are similar to those obtained by airborne hyperspectral sensors, but at much lower cost and with greater accessibility to coastal resource managers. We are using the resulting maps to characterize the spatial pattern of plant communities within the delta and to test the degree to which plant species distribution is controlled by elevation as opposed to other factors such as succession, competition, and disturbance history.

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SALT WEDGE CONTROLLED SEDIMENT DYNAMICS OF THE BRAZOS RIVER ESTUARY, TX: STORAGE IN THE LOWER RIVER, TRANSPORT TO THE SHELF

The purpose of this on-going study is to determine the role that salt wedge dynamics plays in controlling both short-term storage of sediment in the backwater/estuarine portion of the lower Brazos River, TX during low flow conditions and in the deposition of sediment on the shelf during higher flow conditions for a wide, low gradient, passive margin shelf. A time series has been conducted sporadically for stations extending 15 km up river and 7 km offshore from the river mouth spaced ~0.5 km, where profiles of water column salinity, temperature, turbidity and sediment samples for each sampling event. For select sampling events, ultra high resolution swath bathymetry was also conducted to detect changes in bathymetry, using a Benthoos® C3D® bathymetric side scan sonar system. Results to-date reveal that during low to moderate flow conditions (~50-400 m³/s), a well stratified salt wedge extends 1.8 km up river from the river mouth and the suspended sediment is trapped upstream of the salt wedge. Results from extremely low flow conditions (115 m³/s) show that tidal forces can dominate the salt wedge dynamics leading to sediment resuspension within the salt wedge. During the one high discharge event sampled (July 12, 2007) 10 days after peak discharge (2190 m³/s), the shelf waters seaward of the seabed intersection of salt wedge (null point) were well stratified, with a highly turbid fresh water hypopycnal plume and a highly turbid bottom boundary layer both extending ~5 km offshore. Our interpretation of the highly turbid bottom layer is that it was a wave supported boundary layer of recently deposited flood sediments, deposited when the salt wedge was displaced further offshore during peak discharge. Results to-date suggest that the salt wedge provides a highly effective trap of suspended sediment. The initial placement of offshore flood deposition of the Brazos River’s suspended load is controlled by the offshore displacement of the salt wedge.

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A TIME SERIES ANALYSIS OF SEAGRASS COVER IN THE SULAWANEE RIVER ESTUARY

As part of a larger study in Florida’s Big Bend, we are studying seagrass dynamics in the Suwannee River Estuary from the mouth of the Suwannee River, through Horsehoe Cove to the Pepperfish Keys, a distance of approximately 40 km. Between 2001 and 2006, we documented complete loss of 1500 ha of seagrass and thinning of another 1700 ha in the SRE. We found these losses resulted from indirect impacts related to runoff from tropical storms and hurricanes in 2004 and 2005 rather than from physical disturbance. Preliminary analyses of 1984 imagery suggests the losses documented for the period 2001-2006 are part of a longer period of seagrass decline, so we are now analyzing a decadal time series of imagery beginning in 1944 and continuing through 2011. The most recent imagery shows apparent recovery of a considerable amount of seagrass lost between 2001 and 2006. Even with recent gains, however, seagrass cover now is very much lower than in 1944.
The ability to define movement and fate of oil-derived substances in local habitats and food webs is important to defining effects of the Deepwater Horizon oil spill on the northern Gulf of Mexico ecosystem. Although stable isotope (SI) ratios are useful to define source inputs and trophic transfers, distinctive endpoints are needed to distinguish oil-derived sources from background in the ecosystem. To define these endpoints, we opportunistically sampled tar balls, mats, and semisolid oil forms along the shoreline from the FL-AL border to barrier islands of MS. Samples were collected from Jun 2010 to present and analyzed for C, N, S and Si ratios. Data were compared across longitudes and through time to determine if distance or time post-spill mediated SI ratios. To further test "weathering" (sample aging) as a source of variation, we measured shifts in SI ratios of each oil form incubated at 60°C for up to two weeks, using temperature and evaporative processes as a proxy for "weathering." δ13C values in oil-derived materials resembled freshwater sources, averaging -27‰ in most samples, regardless of location or age. δ15N values were more variable, ranging from 1 – 4‰, showing no pattern with location, but decreasing with time. Similarly, samples artificially weathered in the lab, showed no shift in δ13C with duration of exposure to heat, while δ15N decreased. A corresponding increase in C:N corroborated loss of N during "weathering." S data will be aligned with C, N data when available. If assimilated into local food webs, oil-derived substances may be difficult to detect and trace due to ongoing changes in composition of the potentially bioavailable products. Despite the relative stability of δ13C in oil products, detection may be limited to systems where freshwater inputs are low or sufficiently distinct to differentiate oil-derived from freshwater sources. Trophic studies will benefit from multiple indicators of oil exposure and bioassimilation.

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INTEGRATING SYSTEM-BASED MANAGEMENT PROCESSES WITHIN AN EAST COAST ECOSYSTEM

Albermarle-Pamlico National Estuary Program (APNEP) in 2008 embarked on a path to strengthen multiple program operations that together support adaptive management of natural resources within the Albermarle-Pamlico Basin. The proposed steps were to update a 1991 technical assessment of the status and trends in regional ecosystem condition, overhaul the program’s dated (1994) Comprehensive Conservation Management Plan (CCMP), and to develop a first-ever ecosystem monitoring strategy. Stakeholder engagement and contributions was recognized as crucial for implementation and success. Unanticipated delays in all three steps resulted in the opportunity for APNEP staff to propose an additional paradigm for guidance: ecosystem-based management (EBM). EBM concepts were first introduced to program partners during 2009, whereby staff held introductory briefings so key stakeholders could understand and appreciate the potential benefits of pursuing an EBM paradigm. Staff then formed an EBM Transition Team with select partners to develop a proposal to the APNEP Policy Board. The proposal was approved in late 2009 and APNEP began implementing EBM elements into its developing CCMP. This presentation focuses on operational upgrades as a result of EBM Transition Team activities in 2010 and 2011, with emphasis on seven EBM steps: articulate goals-objectives hierarchy, develop ecosystem model for objective attainment, assess current management efforts and identify gaps, develop management strategy, develop monitoring program, assess performance, and manage adaptively.

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VALUE OF DECISION ANALYSIS IN STAKEHOLDER INTERACTIONS FOR THE RESTORATION AND RECOVERY FROM THE GULF OF MEXICO OIL SPILL

The importance of stakeholder involvement in the management of watersheds is receiving greater recognition than in the past, however, interacting with stakeholders is frequently accomplished using informal procedures. It is essential to structure elicitation so that they can be more effective in deriving new objectives and alternatives from stakeholder values. The decision analysis literature offers a wealth of empirically-derived and common sense structures that can improve stakeholder interactions and the information obtained or conveyed during elicitation processes. A case study will be presented to illustrate aspects of the value-focused approach for structuring stakeholder beliefs and perspectives. To demonstrate salient products, major post-oil spill policy documents related to the restoration, recovery, and long-term health of the Gulf of Mexico (GOM) coastal communities were reviewed and an objectives hierarchy containing fundamental objectives and potential measures for the objectives was constructed. The fundamental objectives describe the primary concerns in restoring the viability of the GOM during recovery efforts. Strategic objectives were also elucidated to describe the long-term quality of life aspirations for GOM communities and ecosystems beyond recovery and restoration efforts. In addition, a means-ends network was constructed to differentiate measures from objectives from the fundamental objectives. Means objectives are essential only for their influence in achieving fundamental objectives. The demonstrated products were developed from management reports and policy documents but actual products should be constructed with meaningful stakeholder input. Properly preparing stakeholder elicitation workshops and obtaining useful objectives can be time-consuming and challenging but necessary to ensure a robust management process and better decisions.

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ARE SEAGRASS EDGES ECOLOGICAL TRAPS FOR POST-SET BAY SCALLOPS? IMPLICATIONS FOR RESTORATION

Bay scallop populations crashed throughout the extent of their range. Concomitant with the loss of scallops has been declines in the seagrass habitats within which they typically associate. Because scallops have a life cycle that includes a passively drifting larval stage, rapid growth rate, and a strong seagrass association, they are ideal model organisms for investigating edge effects. By simultaneously collecting settlers (those viable larvae available to settle and metamorphose) and recruits (those settlers which survive some period of time, in this case, 6 weeks) on the same collectors we are able to demonstrate a balance between strong positive and negative edge effects. Within an array of ecologically realistic artificial seagrass units, scallop settlement was significantly enhanced along seagrass edges, regardless of patch type, and likewise, survival was significantly enhanced within patch interiors. Post-settlement loss of scallops was most likely attributed to predation, as high abundances of predators occurred throughout the seagrass mats. Since survival was lowest along the seagrass edge where settlement was highest, it appears that edge habitats represent an "ecological trap" for bay scallops. In addition, a field experiment within naturally patchy seagrass meadows is currently being conducted for comparison with the experimental site to verify the ecological trap hypothesis. As scallops are the target species of many restoration efforts, and as seagrass meadows are shrinking and becoming patchy, it is increasingly important to understand the potential role of seagrass edge habitats.


DENSE HUMAN POPULATIONS NEAR SENSITIVE CORAL ECOSYSTEMS: NUTRIENTS IN THE WATERS OF THE SE FLORIDA REEF TRACK

NOAA/AOML has been conducting an extensive coastal ocean monitoring program off of Southeast Florida. This area supports numerous economically important recreational activities including diving and fishing on the coral reef tracks that run parallel to the coastline. Degradation of these resources has been attributed in part to the influence of land based sources of pollution. Some significant point sources of pollution include six ocean inlets and five treated-wastewater outfalls. This program has sampled some of these point sources for a wide variety of chemical and microbiological parameters and has also installed acoustic Doppler current profiling devices. Two 1-year sampling programs will be presented: 1) an area off of Palm Beach County including the Boynton (South Lake Worth) inlet and South Central outfall, and 2) an area off Broward County including Port Everglades and Hillsboro inlets and the Hollywood and Broward ocean outfalls. Geographic distributions and sources of nutrients, seasonal changes, relevant ocean currents, and implications for effects on benthic ecosystem health will be discussed.

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STABLE ISOТОЕ COMPOSITION OF WEATHERED OIL: IMPLICATIONS FOR TRACING OIL DEGRADATION AND BIOASSIMILATION

Abstract Book 21st Biennial Conference of the Coastal and Estuarine Research Federation
Observations are presented from a benthic observatory in the middle reaches of the York River estuary, VA, USA, that show evidence for both muddy flocs and pellets in the lower 1 m of the water column. This study combines in situ time series estimates of (i) volume concentration and particle size distribution from a Laser In Situ Scattering Transmissometer (LISST) (for 2.5-500 μm) and a high-definition particle camera (for 20 μm to 20 mm), and (ii) water velocity, turbulent stress, mass concentration and settling velocity derived from an Acoustic Doppler Velocimeter (ADV). Mass concentration, mass settling velocity and the abundant 8 μm size class are in phase with velocity and stress, consistent with suspension of relatively dense, rapidly settling and resilient ~90 μm pellets. Volume concentration of the abundant 280 μm class peaks well after stress and velocity begin to decrease, consistent with the formation of lower density, slowly settling and fragile ~300 μm flocs.
The utilization of coastal ecosystems by humans has resulted in widespread loss of precious natural habitat, such as marshlands, seagrass beds and oyster reefs. These habitats provide fundamental characteristics that exist among and between coral reef ecosystems of the world. The coral reefs of the Wider Caribbean are less biologically diverse than those of the Pacific and geographically exist in a far more enclosed system than those of the Pacific. The Wider Caribbean is considerably geographically smaller and comprised of two semi-enclosed basins, influenced by watersheds from South America, Central America and North America. Managers tend to look solely at the local stressors on the coral reefs of the Florida Keys are sometimes ignored or overlooked. In order to understand the sources of stress on coral reefs it is imperative that both managers and scientists understand some of the fundamental characteristics that exist among and between coral reef ecosystems of the world. The coral reefs of the Wider Caribbean are less biologically diverse than those of the Pacific and geographically exist in a far more enclosed system than those of the Pacific. The Wider Caribbean is considerably geographically smaller and comprised of two semi-enclosed basins, influenced by watersheds from South America, Central America and North America. Managers tend to look solely at the local stressors on the coral reefs of the Caribbean, while ignoring the influences of the regional and global stressors. Now, through advanced and continually improved remote sensing capabilities, we can comprehend the vast influences and suspended solids. Damping of resuspension by submerged aquatic vegetation provides accurate representations of algal production, water column respiration, and bottom-biased influences. The classic DO kinetics of the model perform well; the model portion of the eutrophication model, to allow for interactions between solids and various resuspension as a function of waves and currents. The suspended solids component is a second feature is a dynamic suspended solids component which computes sediment resuspension as a function of waves and currents. The suspended solids component is a portion of the eutrophication model, to allow for interactions between solids and various biological influences. The classic DO kinetics of the model perform well; the model provides accurate representations of algal production, water column respiration, and bottom-water hypoxia. The water clarity algorithms also perform well. Application of the algorithms, however, in a widespread system like Chesapeake Bay requires an extensive parameter set which is still under development. Suspended solids are, of course, a significant factor in determining water clarity. As with clarity, their computation requires an extensive parameter set. The model was designed to allow for interactions between biological influences and suspended solids. Damping of resuspension by submerged aquatic vegetation (SAV) is explicitly modeled. Representations of additional processes, such as the formation of biological flocs, await processed-based research and the development of numerical algorithms.

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TALKING TURTLE: USE OF DIAMONDBACK TERRAPINS FOR UNDERGRADUATE RESEARCH EXPERIENCES

We are using the ecology of diamondback terrapins as the focal point of undergraduate experiences in estuarine research. Terrapins are the only U.S. turtle found exclusively in estuaries, occurring from Cape Cod, MA to the Gulf Coast of Texas. Because they have habitat requirements for shallow vegetated embayments/marshes for feeding/development, deeper open water for refuge, and adjacent uplands for nesting, terrapins can be studied from multiple perspectives and over different spatial scales. Most of our field studies have been completed during summer sessions (mark-and-recapture for population estimates; beach walks for nesting assessment; tests for by-catch reduction strategies). During academic sessions, students analyze data sets, develop population models, and complete GIS-based impacts of the breakwaters that are not yet realized but likely to occur, such as expanded marsh growth and reduced pollution, are discussed. Our results suggest that oyster-shell breakwaters may help curb habitat destruction in human-developed watersheds, thereby representing a valuable tool for policies of environmental management.

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THE IMPACTS OF INCREASING DISSOLVED CO2 CONCENTRATION AND FLOW ON CARBON CONCENTRATING MECHANISM IN EELGRASS ZOSTERA MARINA L.

Increasing atmospheric CO2 concentration is predicted to have profound impacts on both terrestrial and marine productivity, due to the increase in available substrate concentration for carbon fixation during photosynthesis. Decreasing pH via increased CO2 concentration in the marine environment changes the carbonate chemistry of the seawater, altering relative ratios of dissolved inorganic carbon (DIC) species. This will be especially important for submerged plants such as sea grasses that cannot utilize bicarbonate efficiently through carbon concentrating mechanisms but are dependent on diffusion of dissolved CO2. Evidence shows that the light saturated photosynthetic rate of the eelgrass Zostera marina L. is carbon-limited, and therefore relies highly on aqueous CO2 concentration [CO2aq]. This carbon-limination is due to the low efficiency of eelgrass to use bicarbonate as a DIC source. The interconversion of bicarbonate and CO2 is catalyzed by the Carbonic anhydrase (CA) enzyme, and the inhibition of this enzyme causes approximately a 50% decline in photosynthetic rates. However, the addition of CO2aq while still inhibiting CA produces a 3 fold increase in photosynthetic rates. Therefore the simple diffusion of CO2aq which is driven by the permeability, may be considered as the predominant carbon uptake mechanism. Permeability is controlled by many variables. This study compared the influence of flow speed and substrate [CO2aq] concentration on the permeability with and without inhibiting the carbonic anhydrase activity. Measuring photosynthetic rates using carbonic anhydrase inhibitor (acetozolamide) at different CO2aq levels while varying flow speed helped to quantify the importance of carbon concentrating mechanisms as a means of C-uptake during carbon limited photosynthesis. This will provide insight into how natural seagrass populations within differing flow regimes will respond to the increased oceanic CO2 concentration.

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MODELING FOR TOTAL MAXIMUM DAILY LOADS (TMDL'S) IN CHESAPEAKE BAY

Modeling has supported the management of Chesapeake Bay since the inception of the Chesapeake Bay Program more than 25 years ago. The development of TMDL’s is aimed at attaining three key water quality standards: dissolved oxygen (DO), chlorophyll, and clarity. DO has always been a focus of the management effort. Quantitative criteria for chlorophyll and clarity are more recent developments. Multiple features have been added to the previous management model of the bay in response to these new criteria. One new feature is a rigorous optical model which determines water clarity from inherent optical properties. A second feature is a dynamic suspended solids component which computes sediment resuspension as a function of waves and currents. The suspended solids component is a portion of the eutrophication model, to allow for interactions between solids and various biological influences. The classic DO kinetics of the model perform well; the model provides accurate representations of algal production, water column respiration, and bottom-water hypoxia. The water clarity algorithms also perform well. Application of the algorithms, however, in a widespread system like Chesapeake Bay requires an extensive parameter set which is still under development. Suspended solids are, of course, a significant factor in determining water clarity. As with clarity, their computation requires an extensive parameter set. The model was designed to allow for interactions between biological influences and suspended solids. Damping of resuspension by submerged aquatic vegetation (SAV) is explicitly modeled. Representations of additional processes, such as the formation of biological flocs, await processed-based research and the development of numerical algorithms.

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RESTORING HEALTHY SHORELINES WITH OYSTER SHELL BREAKWATERS IN THE NORTHERN GULF OF MEXICO

The utilization of coastal ecosystems by humans has resulted in widespread loss of precious natural habitat, such as marshlands, seagrass beds and oyster reefs. These habitats provide many low valuable services to humans and, if continue to be destroyed, the dependability and the exploitation of coastal systems by humans may become economically and environmentally unsustainable. To help revert this trend, we have been testing the cost-effectiveness of restoration methods based on the deployment of subtidal reefs that can be used in a variety of coastal systems, ranging from moderately to heavily perturbed, and expected to restore several types of habitat with relatively modest effort. Namely, the reefs may be colonized by oysters, which may reduce wave energy and increase water clarity, in turn ameliorating conditions for seagrass growth, shoreline accrual and marsh expansion. Here we report on one of our restoration projects in Northwest Point-aux-Pines, Alabama. In 2008 we started monitoring a site and in September 2009 we installed four long-shore breakwaters approximately 100 meters from the shoreline. Using a Before-After Control-Impact (BACI) design, results to date show large settlement of live oysters on the breakwaters (150-400 spat per square meter), and increased abundance of other recreational and commercial species, such as blue crab, speckled sea trout, silver perch, striped mullet and sheepshead, around the breakwaters in relation to control areas. The breakwaters also appear to reduce shoreline erosion rates and, in some cases, lead to enhanced seagrass growtheward of the reef. Other
distribution analyses. The systematic nature of aquatic turtles and the potential linkage of science and policy issues associated with habitat protection/restoration make terrapin research both attractive to undergraduate students and relevant for consideration of coastal conservation measures.

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VARIATION IN NUTRIENT COUPLING BETWEEN WETLANDS AND OPEN WATER OF TWO EVERGLADES RIVER SYSTEMS

We used comparisons of elemental ratios of nitrogen (N) and phosphorus (P) among different resource pools to examine nutrient coupling between wetlands and open water of Shark River Slough (SRS) and Taylor Slough (TS). Along salinity gradients from freshwater sawgrass prairie through a mixed-vegetation oligohaline ecotone to coastal seagrass meadow, we sampled surface water for inorganic N and P; fringing wetland soils for total N and P; and wetland porewater for inorganic N and P. N:P ratios ranged from over 500 to less than 40 and tended to decrease from freshwater through the oligohaline ecotone where P-limitation was less intense. Along the Taylor Slough gradient, however, average N:P ratios never exceeded 200 and were not significantly different for wetland soils and surface water, suggesting a strong coupling of factors influencing nutrient exchange. Soil N:P ratios similar to the SRS transect were similar to TS, but surface water N:P was 3-4 times higher along the entire transect, suggesting weaker coupling of nutrient exchange between wetlands and open water. These patterns demonstrate that proposed freshwater flows for Everglades restoration should be added via diffuse sheet flows—not channelized flows—to enhance water-wetland interaction.

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LAGRANGIAN STUDIES IN NARROW AND WIDE ESTUARIES

Results from recent dye studies in the James River estuary will be presented and put in context with dye studies conducted in the Hudson River estuary in 2002. In both studies dye was injected into the bottom boundary layer and tracked by a pair of vessels for at least a tidal cycle after injection. Both studies included a series of injections covering a range of tidal conditions and stratification. While both studies emphasized the role of lateral circulation and vertical entrainment the relative importance of these processes differs between these two systems. In particular the evolution of the dye patch in the narrow Hudson was dominated by the entrainment of halocline fluid into the bottom boundary particularly during the tide. This entrainment was evident by a rapid freshening of the core of the dye patch in the narrow James River whereas the core of the dye patch remained relatively constant throughout the flood tide. This reduced freshening appears to be related to lateral advection and mixing of saline water into the dye patch that competes with vertical entrainment of halocline water from above. Finally, moored data provides a detailed characterization of the lateral flows which are forced by both Ekman processes and differential advection. These tidal periodic lateral flows impact the tidally averaged momentum balance and tidal period stratification. In particular, lateral circulation tends to stratify the estuary on the flood tide and reduce or even eliminate the tidal period variability in stratification predicted by the classic model of tidal straining.

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RADIONUCLIDE TRACERS OF SUBMARINE GROUNDWATER DISCHARGE ON AN OCEAN ISLAND (GUAJAMAN)

Ocean islands, while a minor fraction of the earth’s coastline, are thought to support as much as one-third of the global land to ocean submarine groundwater discharge (SGD). Such estimates are derived from a water balance, which is primarily the residual between two large terms: mean annual precipitation and evapotranspiration. Given the uncertainties associated with this approach and the disproportionate role that islands may play in global SGD, independent and direct estimates are required. This paper will focus on a submarine groundwater discharge method intercomparison on Guam, an island in the western Pacific Mariana Island chain. The island geology is a mix of volcanic and karst, as a result, SGD is dominated by submarine seeps and springs. Radium isotopes and radon were applied as tracers of SGD in Tumon Bay, a large, semi-enclosed lagoon on the northwest coast. Water fluxes derived from the isotopic methods will be compared with a salt balance for the same time period, as well as two historical estimates of SGD: flume capture of large submarine springs and porewater chloride modeling. Reasonable agreement among these five methods suggests that the water balance approach may be suitable for application on a global basis.

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THE METABOLIC EFFECTS OF HIGH PCO2 AND TEMPERATURE ON AN IMPORTANT REEF MACROALGAE, HALIMEDA DISCOIDEA

The partial pressure of atmospheric CO2 (pCO2) is expected to rise to ~800 ppm by the year 2100, lowering ocean pH ~0.2-0.4 units and increasing temperature ~4°C. The effects of pCO2 enrichment and rising temperatures, as well as resulting synergistic effects on calcifying and non-calcifying macroalgae and seagrasses are unclear. In the present study, we examined the elevated and ambient temperature (24°C [ambient] and 28°C [-4°C] and pCO2 [387 [ambient] and 800 ppm] effects on photosynthesis, respiration and calcification rates of an important reef macroalgae, Halimeda discoidea (March, 2011). This research is part of our broader program investigating the effects of climate change on tropical marine macroalgae and seagrasses in mesocosm and field studies. The H. discoidea experiments were run in mesocosms (500 L) with temperature and pCO2 (CO2 gas) treatments individually and in combination treatments (n=3). Productivity and respiration rates were measured in the light (2.5 h) and dark (19 h), and calcification determined using the alkalinity anomaly technique. Two-way ANOVA indicated a higher rate of GPP and NPP in the 2100 pCO2 treatment regardless of temperature. Similarly, respiration was higher in the elevated temperature treatments regardless of pCO2. Interestingly, high pCO2 ameliorated the effect of high temperature on respiration, suggested by a significant interaction of pCO2 and temperature (p =0.05) and a lowering of O2 consumption under elevated pCO2. Calcification rates followed productivity, leading elevated productivity with enhanced calcification for this species at 2100 levels of pCO2 , as well as enhanced calcification with +4°C. These results suggest H. discoidea may be able to physiologically adapt to elevated pCO2 and temperature during the spring; however, our future studies will elucidate if this enhanced response will be found during maximum temperatures in summer and be consistent across calcifying and non-calcifying species.

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A COMPARISON OF GPS AND LIDAR DEMS

Digital elevation models (DEMs) were compared to characterize how well airborne lidar (light detection and ranging) data depict the microtopography of a salt marsh. 72,000 GPS (global positioning system) points and 700,000 lidar points from a 1km2 salt marsh island were linearly interpolated onto identical DEM grids. Overall, 78% of lidar elevations were within 2cm (0.008m) of the high precision GPS elevations. Spatial arrangement of difference values reveals that lidar performed best on the marsh platform, and poorly along tidark creeks and creek heads. Also, the overall shape of the salt marsh was poorly defined, even where lidar data were within the reported range of accuracy. Initial observations indicate that lidar appears to be a robust tool for mapping intertidal landscapes while spatial analyses show that lidar DEMs may not adequately resolve the microtopographic variations of a salt marsh. For research questions that require accurate depiction of small scale tidal creek networks and subtle terrain features lidar data should be augmented with other information.

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HYDRODYNAMIC AND WATER QUALITY MODELING IN SOUTH FLORIDA, USA

The South Florida wetlands ecosystem is an environment of great ecological diversity. Over the past 100 years, the combined effects of agriculture, urbanization, and water management have caused negative impacts to the ecosystem. Water quantity and quality modeling are necessary to identify management strategies that maximize ecological benefits, while meeting flood control and water supply uses. We present two studies of South Florida wetlands. One is for the A.R.M. Loxahatchee National Wildlife Refuge, and the other for the Ten Thousand Islands National Wildlife Refuge (TTONWR). For the former, three approaches were utilized to model the hydrology and water quality. The first is
compartment-based model using Berkeley Madonna. The compartment configuration is based on a water-quality cluster analysis of long-term and year-round data. The second uses the spatially-explicit MIKE FLOOD and ECO Lab modeling framework (DHI). This model dynamically links a 1-D channel model with a 2-D uniform grid overland flow model. Advection and dispersion along with other reactive and settling processes are modeled with the ECOLab module. The third is the 2-D Finite Element model of ADf developed by USACE. ADf represents both marsh and canal in one mesh, thus helps to better represent the nutrients intrusion from a perimeter canal into the interior marsh. For the TTNWR, a mass-balance model was setup using Berkeley Madonna. The model takes into account the Bay water level to the south of the area, the flow at the bridges under Hwy 41, as well as precipitation, evapotranspiration, and groundwater seepage. The model is intended to provide a better understanding of the hydrology of the area, and will allow the evaluation of restoration efforts, predicting changes in water salinity under different management scenarios. Statistical analyses of model results demonstrate that these models are capable of temporal and spatial prediction of water levels and water constituent concentrations.

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THE TAR - PAMLICO HYDRODYNAMIC AND WATER QUALITY MODEL: AN ASSESSMENT TOOL FOR FRESHWATER INFLOW, SALINITY-MEDIANATED HABITAT, AND WATER QUALITY

Greenville Utilities Commission (GUC) gets the majority of its water supply from the lower Tar River, but is also exploring conjunctive groundwater uses and aquifer storage and recovery to meet future water needs. In order to determine the future sustainable level of water withdrawal from the Tar River, Cardno ENTRIX built and calibrated the Lower Tar Pamlico Model (LTPM). The LTPM model is an application of a widely used hydrodynamic and water quality model (Environmental Fluid Dynamics Code or EFDC) with the emphasis on changes in river and estuarine habitat and water quality as a result of water withdrawals. The LTPM is a fully three-dimensional hydrodynamic and water quality model that simulates tidal conditions, flow, salinity, and water quality in approximately 58 miles of tidally-influenced river and estuary from Greenville to the mouth of the Pamlico Estuary. The model is being used to simulate water levels, flows, velocities, and water quality (dissolved oxygen, nutrient concentrations, chlorophyll a, and total suspended solids) throughout the system. Hydrodynamic and water quality modeling will be used to assess potential impacts that additional withdrawals could have on existing water quality within the Pamlico River, and evaluate the environmental flow needs of the Tar and Pamlico Rivers for fish and aquatic life, water quality, and other beneficial uses. A full range of hydrologic analysis and modeling, environmental flow impact analysis, and assessment of low-flow/drought management strategies will help GUC determine available water from the Tar River while protecting aquatic resources.

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ESTUARINE FLOW Q UANTIFIED WITH ISOHALINE COORDINATES: CONTRASTING LONG AND SHORT ESTUARIES

We use the isohaline coordinate method to compare the exchange flow in two contrasting estuaries, the long (with respect to tidal excursion) Hudson and short Merrimack River, using validated numerical models. The isohaline method averages fluxes in salinity space rather than in physical space, yielding the isohaline exchange flow that incorporates both subtidal and tidal fluxes and precisely satisfies the Knapen relation. The isohaline method can be consistently applied to both subtidal and tidally dominated estuaries. In the Hudson, the isohaline exchange flow is similar to the Eulerian analysis, and the conventional estuarine theory can be used to quantify the salt transport based on scaling with baroclinic pressure gradient. In the Merrimack, the isohaline exchange flow is much larger than the Eulerian quantity, indicating the dominance of tidal salt flux. The exchange flow does not scale with the baroclinic pressure gradient but rather with tidal volume flux. This tidal exchange is driven by tidal pumping due to the jet-sink flow at the mouth constriction (Stommel and Farmer 1952), leading to the linear dependence of exchange flow on tidal volume flux. Finally, to characterize the exchange processes among different systems, we propose a tidal conversion parameter Qin/Qprism which measures the fraction of tidal inflow (Qprism) that is converted into net exchange (Qin). We also demonstrate that the length scale ratio between tidal excursion and salinity intrusion provides a characteristic to distinguish estuarine regimes.

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EFFECTS OF WATERSHED DEVELOPMENT AND CLIMATE EVENTS ON ECOSYSTEM HEALTH IN LAGOONS IN THE NORTH CENTRAL GULF OF MEXICO

Anthropogenic and climate stressors impact the health of coastal systems, but the synergistic effects of both kinds of stressors are not well understood. Long-term (2000 – 2008) water quality and biological data were collected from three shallow lagoons in the Perdido Bay system, Florida. These lagoons have similar physical and hydrological characteristics but cover a wide gradient of human watershed development. Here we examine (1) long-term water quality and biotic trends and responses to increasing watershed developments, and (2) the interactions between the urban stress and climate events. Nutrient (total dissolved nitrogen, nitrite, and inorganic phosphate) concentrations increased with higher urban development in the studied lagoons. Higher concentrations of chlorophyll a in both water column and bottom were found with increased urban development. No seagrass was observed in the highly developed GC lagoon, most likely due to elevated shading by high water column chlorophyll a concentrations. Seagrass was healthiest in the pristine lagoon over the whole study period. Our results show that climate events increased nutrient stress from the watersheds but did not shift the overall biological trends. Yet, longer term monitoring is needed to fully detect the interactions of urban development and other longer-term climate alterations such as sea level rise.

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SPATIAL AND TEMPORAL VARIABILITY OF BOTTOM DISSOLVED OXYGEN IN ST. LUCIE ESTUARY, FLORIDA

Dissolved oxygen (DO) is a commonly used indicator of a healthy and well balanced ecosystem. Using data collected monthly (1995 to 2010), weekly (2000), and every 30 minutes (2005), we examined spatial and temporal variability of bottom DO in the St. Lucie Estuary, Florida. DO showed a strong longitudinal gradient from the upper estuary to the lower estuary. Hypoxia (< 2 mg/l) occurred mostly in the upper estuary (i.e., up to 30% of DO at the mouth of its three tributaries) and was less frequently observed in the lower estuary (i.e., did not occur at inlet stations). DO exhibited a distinctive seasonal pattern with hypoxia more frequently observed in the wet season than in the dry season and strong interannual variations with an overall long-term (1995-2010) decrease in the occurrence of concentrations less than 4 mg/l. In addition, substantial short-term variability of bottom DO over diel and weekly scales was also observed. Hypoxia could develop on timescales of days (e.g., 3-4 days) during a stratification event and dissipate within a couple of hours. On a monthly basis, bottom DO was highly correlated with temperature, water column stratification, and weakly correlated with water column chlorophyll a concentration. However, weekly time series showed higher chlorophyll a concentrations were often followed by lower DO in bottom waters. Annual mean DO tended to decrease as annual mean chlorophyll a increased, suggesting that reductions in chlorophyll a may result in higher dissolved oxygen concentrations. The observed patterns of bottom DO variability suggest that both physical factors (e.g., temperature, water column stratification) and chlorophyll a concentration be considered in assessment and management of dissolved oxygen concentration in the SLE.

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THE ROLE OF PHOTOSYNTHETIC BUBBLE PRODUCTION IN COASTAL PERMEABLE SANDS

In coastal permeable sediments, microphytobenthos produce oxygen bubbles in the upper layers via photosynthesis. Gas formation in these environments differ greatly from muddy sediments, yet there is little data available on its role in these sandy environments. The fate of these small interstitial gas bubbles vary depending on external forces such as waves, tides
or biochemical processes. They may remain in the sediment, affecting the hydraulic characteristics of the sediment or surface, through ebullition. Over time, the gas is expected to change in volume and composition as the gas equilibrates with the surrounding environment. All of these processes may alter the biogeochemical processes in the sediment and water column. Laboratory experiments using an in situ dye tracer have indicated the potential for gas ebullition to have a marked effect on solute exchange. Field sampling of gas bubbles demonstrated changes in volume and composition of the gas bubbles throughout the day/night cycle, as well as seasonal variation. The projected human population increase in coastal environments in the Gulf of Mexico will inevitably amplify loading of nutrients and organic matter, leading to enhanced biological activity in the sediment and water column. Understanding the role of ebullition in solute exchange can have important implications for nutrient budget calculations, coastal management and preservation efforts.

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ELEVATED CO2, SEA-LEVEL RISE AND SEDIMENTATION INTERACT TO REGULATE BIOLOGICAL CONTRIBUTIONS TO SOIL ELEVATION DYNAMICS IN COASTAL WETLANDS

Biological processes controlling organic matter contributions to soil volume are important for maintaining soil surface elevations, especially in sediment-deprived marshes. Multiple global change forcing factors have the potential to alter these processes, thereby affecting the capacity of marshes to maintain surface elevations relative to sea-level. In this study, we conducted a controlled mesocosm experiment to examine interactive effects of atmospheric CO2 concentration (ambient, elevated), sea-level rise (+2, +4, and +8 mm/yr), and hurricane sediment input (none, +5 cm) on biological contributions to elevation change. We examined these responses in a brackish marsh community comprised of two common marsh species, Schoenoplectus americanus, a C3 sedge, and Spartina patens, a C4 cordgrass. This experimental approach permitted examination of multiple interacting factors on biological contributions to elevation change via root zone expansion or contraction, and identification of important mechanisms controlling elevation dynamics. After one year of experimental manipulation, community composition shifted to favor the C4 species, especially in the intermediate sea-level rise treatment. Vertical change was greatest in the intermediate sea-level rise treatment, a response that may be driven by plant responses. In addition, vertical change was strongly driven by sediment addition, regardless of CO2 or sea-level rise treatment. As we continue to monitor responses, root ingrowth into the sediment additions and a continued C4 response may emerge as important biogenic contributions to elevation change. These initial results underscore the need to examine biological responses to multiple factor interactions in order to understand mechanisms for maintaining marsh elevations relative to sea-level.

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THE DOCUMENTATION AND MONITORING OF SUBMERGED AQUATIC RESOURCES IN LAKE WORTH COVE, FLORIDA: A COLLABORATION BETWEEN RESEARCH, MANAGEMENT, AND EDUCATIONAL ENTITIES

Lake Worth Cove is one of the few protected regions of Lake Worth Lagoon, an urban estuary in Palm Beach County, Florida. The nearly 40 hectare Cove is located within the boundaries of John D. MacArthur Beach State Park, an area managed by the Florida Park Service. MacArthur Beach is one of 23 parks located in the Park Services’ District 5 region, a region that spans nearly 500 kilometers of coastline from Ft. Pierce to Key West. Five biologists are currently on staff with the Service to monitor the various systems within this region. There was a limited understanding of the submerged aquatic resources within the cove due to a lack of staffing and resources. If changes were to occur in community composition, either by gradual succession or a catastrophic event, they would go undetected because of an absence of baseline data. In recognition of the need for a biodiversity baseline and a long term monitoring plan, a cooperative effort between the Park, university faculty, undergraduate research assistants and volunteers was formed in 2010. Using nondestructive sampling techniques, seasonal surveys were conducted within the cove. The results were surprising: all seven of Florida’s seagrass species were found here, including the federally listed Johnson’s seagrass and widgeongrass, a species never documented previously in the cove. In one two-hectare plot, all seven species were found together. Similar to the Indian River Lagoon, this area has the highest seagrass biodiversity of any estuary in the western hemisphere.

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INFLUENCE OF HABITAT TYPE ON MULTIPLE PREDATOR EFFECTS WHEN INVASIVE GREEN CRABS (CARCINUS MAENAS) AND NATIVE ROCK CRABS (CANCRUS IRORATUS) PREY ON SOFT-SHELL CLAMS (MYA ARENARIA)

Non-independent multiple predator effects occur when predators foraging together have different individual consumption rates than predators foraging alone. While multiple predator effects have been well studied, there has been little emphasis on how environmental heterogeneity and behavioral mechanisms affect consumption rates. To address these knowledge gaps, we conducted a laboratory experiment examining predation by invasive European green crabs (Carcinus maenas) and native rock crabs (Cancer irroratus) on commercially valuable soft-shell clams (Mya arenaria). In coastal habitats of eastern Canada, these crab species overlap in distribution and likely compete, as their diets overlap and they occupy similar habitats. Predator treatments (single crabs, conspecific pairs and heterospecific pairs), with crabs of similar sizes, were established on either sand or sand with artificial seagrass and offered juvenile clams. Habitat type had no effect on predation rates of single predators, but paired predator showed lower overall consumption in seagrass. Single and paired green crabs consumed a greater proportion of clams than single and paired rock crabs, respectively. To test for non-independent multiple predator effects, we compared predicted values, generated by the multiplicative risk model using single crabs, to observed values for paired predator treatments. Independent multiple predator effects were detected for all paired predator treatments and habitat types. Although aggressive interactions were observed in all paired predator treatments, encounters between predators did not reduce foraging time. Single crabs had similar search and handling times as crabs foraging with conspecifics, as did single rock crabs and rock crabs foraging with heterospecifics. These results suggest that interactions between green and rock crabs may not hinder their ability to forage, nor reduce their per capita consumption of soft-shell clams in sand and seagrass habitats.

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MODELING THE IMPACT OF DROUGHT ON SOUTH CAROLINA BLUE CRABS

Blue crabs have been experiencing severe declines across their entire geographic range. In South Carolina, annual landings show significant correlations with rainfall, river discharge and average marsh salinity. The causal mechanisms for these correlations are not yet known, but salinity has the potential to alter fishing effort, increase disease, reduce settlement, slow growth, and increase mortality. To evaluate the relative importance of these direct and indirect effects of salinity on blue crab population structure, we conducted replicate simulations using the SCBRCAS spatially-explicit individual based model. Using water quality parameters from three years of field observations in the ACE Basin NERR we constructed a spatially-explicit model of the ACE Basin crab habitats with water conditions based on seasonal and annual variation in river discharge. Then we compared the relative importance of the direct effects of salinity on crab settlement, growth and survival, and the indirect effects of salinity on crab disease, prey, and predators. During times of low river discharge, average salinity increases, disease prevalence increases, and crab abundance decreases. However, the indirect effect of salinity on fishing effort is minimal. Our preliminary results suggest that salinity influences crab abundance through a mixture of both direct (survival) and indirect effects (disease). Future research will compare the forecasts of crab abundance from the model with field estimates of crab abundance across a range of drought conditions.

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INTEGRATED ESTUARINE SYSTEMS MANAGEMENT: ROLE OF ADAPTIVE HYDRAULICS MODEL IN ECOSYSTEM RESTORATION IN ESTUARIES, COLUMBIA RIVER ESTUARY

The Columbia River is the largest river in the Pacific Northwest region of North America and has the greatest flow of any North American river draining into the Pacific Ocean. The Columbia River Estuary is located in northwest Oregon and southwest Washington, starting near Astoria, Oregon and ending at about river mile 46. The Lower Columbia River Basin includes all tributaries and their watersheds that drain into the Columbia River from its mouth to river mile 146. Restoration, habitat enhancement and habitat creation efforts are crucial within the lower Columbia River Basin and the Estuary in order to mitigate the effects of human activities since the 1870s. USACE Engineering Research and Development Center, Coastal and Hydraulics Laboratory, Estuaries Engineering Branch recently developed large scale Adaptive Hydraulics (AdH) model for the lower Columbia River and Willamette River for use as decision support tool in planning various projects within the tidally influenced portion of the Columbia River. AdH is the U.S. Army Corps of Engineers’
next generation unstructured multi-dimensional mass conserving finite element physics based hydrodynamic model code that utilizes automatic, run-time grid refinement and un-refinement to obtain the best hydrodynamic solution for the least computational cost. The hydrodynamic portion of the model code includes: shallow water equation methods for estuarine, riverine, etc. problems; Navier-Stokes methods for calculation around structures such as fish ladders; and unstructured ground water methods. Objective of large scale AdH Lower Columbia River model is integration of hydraulics and ecosystem simulation technologies with water resource management missions to support planning ecosystem and habitat restoration in estuarine systems.

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LOCATION- AND SEAGRASS-SPECIFIC ASSEMBLAGES OF BACTERIA IN SEAGRASS EPiphyte Biofilms Along the South Texas Coast

Concern for the global decline of seagrasses points to a need to understand the biogeochemistry of the interface between seagrasses and water. Bacterial communities can be both drivers and indicators of the physical and chemical environment, so characterization of these communities and their metabolic activities will provide valuable insights. Representative bacterial species assemblages on both Halodule wrightii and celluloose substrates were compared between Cupris Christi Bay estuary (CC Bay) and the Upper Laguna Madre hypersaline lagoon (ULM). Species assemblage profiles were generated by denaturing gradient gel electrophoresis (DGGE) following amplification of 16S rRNA genes using primers for specific groups of bacteria. Unique diversity was observed for bacterial assemblages obtained from CC Bay vs ULM, as well as for seagrass vs artificial substrates. Sequences from clone libraries indicate highly diverse assemblages not fully characterized. Comparison to Ribosomal Database Project II reveals operational taxonomic units consistent with an interface between aerobic and anaerobic environments.

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Benthic Oxygen Fluxes Measured in the Gulf of Mexico Using the Eddy Correlation Technique

The aquatic eddy-correlation technique can be used to non-invasively determine the oxygen flux across the sediment-water interface by analyzing the covariance of vertical flow and oxygen concentration in a small measuring volume above the sea bed. In environments experiencing changing bottom currents and wave action, induced pore-water exchange influences oxygen flux due to the transport of reduced substances into and out of the sediment, and can vary both spatially and temporally. Here we report results from eddy correlation oxygen flux measurements conducted at four sites in the Northeastern Gulf of Mexico. The sediments at the shallow study sites consist of permeable sands, and are characterized by high microphytobenthos activity. Despite the relatively low carbon content of these sands, oxygen fluxes reached up to ~345 mmol m~2~d~1~m~2~d~1~, demonstrating the high metabolic activity of these permeable sands caused by the biocatalytical filtration process. Variation in flux magnitude was mainly caused by changes in light, flow, and wave action, emphasizing the importance of benthic photosynthesis and advective pore water exchange for the flux dynamics in permeable sea beds.

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The Contribution of Vegetation to Tidal Marsh Accretion is Underestimated by Measurements of Mass of Organic Matter

The accumulation of plant organic matter is an important factor in the vertical accretion of tidal salt marshes. When assessing the contribution of organic matter to vertical accretion, many researchers assume the relationship between organic matter mass and volume is constant, applying a conversion of 1.14 g to 1 cc. We have tested the validity of this assumption, examining the mass-volume relationships of fresh roots and rhizomes and macro-organic matter from marsh cores. Our study sites included five marshes from three major estuarine systems: Kouchibouguac National Park on the New Brunswick coast of the Gulf of St. Lawrence, Isle Verde on the St. Lawrence River estuary of Quebec, and Dipper Harbour, Allen Creek and John Lusby National Wildlife Area on the Bay of Fundy. The tidal amplitudes of these estuaries range from micro to macro-tidal, respectively. Fresh roots and rhizomes were extracted from ingrowth cores deployed in the high (Spartina patens) marsh of Kouchibouguac National Park on the New Brunswick coast of the Gulf of St. Lawrence, Isle Verde on the St. Lawrence River estuary of Quebec, and Dipper Harbour, Allen Creek and John Lusby (a recovering marsh). We measured the volume of fresh root and OM by displacement and compared volumes to the dry mass and loss on ignition (LOI) of dried material. Our analyses reveal consistently significant linear relationships between LOI and mass with volume, but that the nature of these relationships varies with marsh. More importantly, the commonly used factor to convert LOI to volume underestimates the volume of organic matter, thus the importance of belowground production to salt marsh vertical accretion.

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Water-Depth Correction Module for Seagrass Mapping Using Hyperspectral Data

The substantial difference between the reflectance values at the red and near infrared (NIR) regions has been used to develop vegetation indices for remote sensing of green plants. These spectral indices, however, may not be effectively used for underwater plant detection due to numerous factors including the influence of the water column which interferes with reflected signals from the seafloor. We empirically differentiated the energy absorbed by water and scattered from the water column using an indoor water tank with hypothetical surfaces that absorb or reflect a known amount of incoming light. Using the experimental data, a function was developed to correct reflectance measured from a shallow water body for the water effects. When applied to independently measured reflectance of undervegetation; the algorithm significantly enhanced vegetation signals, especially in the NIR region. A Graphical User Interface (GUI) was developed using the IDL language and a water correction module as a function call under the ENVI’s main menu bar so that the user can simply locate and select the option in order to call and use the module. The algorithm was successfully used to correct the water effects when applied to airborne hyperspectral image data obtained over Halodule wrightii seagrass beds. The contrast between the dark Halodule patches and the bright sand increased in the bands between 500 and 800 nm after the correction. The correction algorithm also increased Normalized Difference Vegetation Index (NDVI) values for the seagrass pixels by restoring the upwelling signal in the near infrared. Therefore, this experimentally-driven algorithm has a potential to improve mapping capabilities of seagrass beds and invasive aquacultures in shallow water bodies.

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Fluxes of Nutrients in Sedimentary Pore Water: Evidence of Phosphorite Formation in the South Korea Plateau, East sea

In order to estimate the fluxes of nutrients in sedimentary pore water and the formation mechanism of phosphorite, we analyzed dissolved nutrients (ammonium, nitrate, nitrite, silicate and phosphate), dissolved trace metals (manganese, vanadium and phosphorus), and solid phase organic matter and sediment characteristics (porosity, dry bulk density) in 4 box core samples along the slope of the South Korea Plateau, East Sea. Dissolved phosphate concentration in bottom water and pore water at phosphorite collected site was 2.3 times higher than the other sites. The flux of ammonium from sediment to bottom water was estimated to be 15.6-54.2 mmol/m2/yr, nitrite and nitrate, 22.7-73.2 mmol/m2/yr; phosphate, 9.5-25.9 mmol/m2/yr and silicate, 16.8-30.1 mmol/m2/yr. Especially, phosphate ion is estimated to be 15.6-54.2 mmol/m2/yr; nitrite and nitrate, 22.7-73.2 mmol/m2/yr; phosphate, 9.5-25.9 mmol/m2/yr and silicate, 16.8-30.1 mmol/m2/yr. The flux of ammonium from sediment to bottom water was especially high, while phosphate ion was relatively low. The concentration in bottom water and pore water at phosphorite collected site was 2-3 times higher than the other sites. The difference of geochemical properties between phosphorite and other sites suggests that redox boundaries are located at Oxygen Minimum Zone (OMZ). The vertical profiles of redox sensitive ions (nitrate, nitrite, phosphate and silicate) suggest that redox boundaries are located at 5-10 m below the surface sediments. Based on the correlation between phosphorite-bound phosphate, phosphate reduction or re-oxidation at the redox boundary appears to facilitate the diagenetic processes of phosphate formation in the topmost sedimentary layer.

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SHALLOW LAGOONS IN THE NORTH CENTRAL GULF OF MEXICO: LONG-TERM TRENDS IN BENTHIC METABOLISM

Shallow lagoons along the coast of the Gulf of Mexico are sites of intense secondary production, most of which is fueled by active communities of benthic primary producers and export from adjacent wetlands. Because of their relatively low flushing rates and proximity to land, these lagoons are particularly vulnerable to changes in the watershed, such as increases in nutrient loading and excessive input of organic matter. This vulnerability has important implications for monitoring, as the effects of eutrophication are potentially easier to spot in a lagoon, compared to other parts of coastal ecosystems. Here we report the results of an ongoing long-term (10 years) monitoring project in three shallow lagoons with different levels of human disturbance, located in the Perdido Bay area, Florida. We determined metabolic rates in vegetated and bare sediment, relating these measurements to producer biomass, detrital biomass, inflow density, water quality and environmental parameters. In the two lagoons with seagrass beds, we noted a long-term decline in primary production within the beds, associated with a gradual decline in seagrass biomass. Benthic primary production in bare sediment exhibited seasonal fluctuations. However, it remained constant over longer timescales at each of the sites. Our results indicate that meteorological forcings and anthropogenic disturbances may be compounding factors influencing benthic metabolism in shallow coastal lagoons.

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USING A HYDRODYNAMIC MODEL TO ASSESS THE EFFECTS OF WATER AGE ON PHYTOPLANKTON GROWTH IN THE LOWER ST. JOHN'S RIVER

Water age has been used in the Lower St. Johns River EFDC (Environmental Fluid Dynamics Code) hydrodynamic model as a surrogate for water residence time during the model period of 1996-2006. Unlike traditional methods of calculating residence time using volume/flow rate, water age is calculated for each model cell, allowing it to vary spatially throughout the model domain, and temporally throughout the model run. Water age is also useful for analyzing flows in lakes, both in the main stem and off-line, where water can become trapped in certain areas due to hydrodynamics and geological features. Water age was found to be particularly useful for the analysis of algal blooms, because in this nutrient-rich estuarine river, increased residence time allows greater exploitation of available growth resources (i.e., nutrients) by the phytoplankton. In regression analysis, water age was positively correlated with chlorophyll-a, in cases where nutrients were not limiting. Water age calculations take advantage of passive numerical “dye” in EFDC. The dye in the model uses the same advection-diffusion equations as salinity. Water age assumes an age of zero for all of the water entering the model. The dye, with an initial concentration of zero, is added to the model at each water inflow location to indicate an age of zero. As the parcel of water containing the dye moves through the model over time, the dye concentration increases in the parcel of water proportionally to the amount of model time that has elapsed since the parcel entered the model domain. In general, water age increases moving downstream, however, a decrease can be seen near tributaries.

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MONITORING EFFORTS FOR DISTRIBUTION, FREQUENCY, AND ABUNDANCE OF HALOPHILA JOHNSONII THROUGHOUT ITS SOUTHERN RANGE

Johnson’s Seagrass (Halophila johnsonii) is a species of small seagrass unique to the state of Florida. In 1998, H. johnsonii was listed as a “threatened” species due to 1) a limited geographic range (200 km stretch of the southeast coast of Florida), 2) patchy distribution throughout the range, and 3) a lack of observed sexual reproduction (i.e. no male flower has been found). The northern area of the range is defined as Sebastian Inlet to Jupiter Inlet, and the southern area from Jupiter Inlet to Virginia Key in northern Biscayne Bay. The northern range has been thoroughly monitored by St. Johns River Water Management District since 1994. In 2006, the H. johnsonii Recovery Team tasked the Florida Fish and Wildlife Research Institute with implementing a complementary monitoring program for the southern range. Thirty sites were chosen, with three 0.5 m belt transects established for monitoring at each site. Within the first 5 yr of a 10 yr monitoring period, H. johnsonii continues to show a high level of patchiness throughout the southern range with more frequent appearances/disappearances in northern Biscayne Bay than in other southern areas. Both frequency and abundance of H. johnsonii are highly variable at the transect level, but relatively consistent at the site level over time. Over the last 5 yr, the H. johnsonii population has remained stable throughout the southern extent of its range. The goal of this monitoring is to assess persistence of the H. johnsonii population over time, with the possibility of delisting the species if 1) it does not show a significant declining trend throughout its geographic range and 2) the present geographic range does not decline during the monitoring period of 2006 to 2015.

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A REDESIGN OF PONCE DE LEON INLET, FL: PREDICTED CHANGES USING CMS, A FULLY-INTEGRATED NUMERICAL MODEL

Since 1999, a 305 m parallel extension of Ponce de Leon Inlet’s south jetty has been recommended. The feasibility study of Smrnick and Taylor (1999) stated the necessity for a detailed, fully-coupled hydrodynamic/sediment transport model to obtain a complete description of morphologic changes. As Ponce is a key inlet for estuary flushing and is world-renowned for consistent surf breaks, local stakeholders have halted redesign efforts. To address their concerns, several design options were modeled using the fully-integrated Coastal Modeling System (CMS) to predict hydrodynamic and morphologic changes in a 10-month period, capturing fair-weather and storm conditions. CMS is a finite-volume, depth-integrated circulation model coupled with a half-plane, spectral transformation wave model that includes processes relevant to structured inlets. Three sediment transport sub-routines are available for the fully-integrated approach which provides an evolving bathymetric grid for each new interval of the hydrodynamic module. Design alternatives included a myriad of options to improve three major areas: severe shoaling of the south spit, mechanical stress on the north jetty caused by the shifted navigation channel, and hazardous passage along that channel during high wave and wind events. Creation of an artificial hard bottom by adding rubble mound to the deep and present location of the shifted navigation channel benefited the structural integrity of the north jetty by impeding self-scouring. Dredging to re-establish the navigation channel to the midline (z = 4.6 m) had a positive effect on self-scouring of that area and reduced shoaling, keeping it limited to the southern half of the inlet. These modifications combined with a 0.7 m elevated rubble mound south jetty extension and 0.5 m submerged 45° spur predicted an even distribution of flow across the inlet and interruption of transport into the inlet from the south, allowing the ebb shoal to be more efficient at bypassing.

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LINKING HYDROGEOEMORPHOLOGY AND FOOD WEBS IN SALT MARSH INTERTIDAL CREEKS

Intertidal creeks are highly photic systems that serve as both destinations and conduits for numerous precocious fishes and shrimps to access rich sources of prey. Studies in North Inlet estuary, SC, demonstrated links between geomorphological features of 8 intertidal creeks and the patterns and extent of their use by tidal migratory nekton. Herein we extend these findings through ecological network analysis of foodweb structure within 2 creeks and infer its relationship to geomorphology and potential influences of hydrological condition and change. Most abundant nekton species fed largely on epibenthic or benthic invertebrates with high trophic efficiencies lower in the food chain. Nekton biomass (total and individually the most abundant 4 species) had previously been found generally to be greatest in shallow and low flow creeks with gentle sloping sides and near upland. Thus, alterations to the existing creek geomorphology or flow regimes should impact the linkage between benthos and nekton with low effective trophic levels and between these nekton and predators. Direct human activities of dredging and filling, indirect activities that alter flow regime, or accelerating sea-level rise have the potential to alter creeks as primary nurseries and sources of food for the larger estuary.

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COASTAL WETLANDS AND SEA-LEVEL RISE - IT ISN'T A BATHTUB!

Often coastal flooding from sea-level rise is portrayed like a bathtub. As sea-level rises, the surface of the coast is flooded as if it were a stationary surface. However, coastal wetlands have kept in step with sea-level for millennia. The future coastal landscape depends on how well these wetlands can continue to increase elevation in the face of climate change and accelerated sea-level rise. Numerous factors are involved, including rates of sea-level change, regional and global climate related conditions, patterns of tidal flooding, sediment
load within the water, plant species in the community and their ability to grow, decomposition rates of plant material, and local human activities. Complex interactions of these factors intertwine physical, chemical and biological processes with feedbacks and time lags that make rocket science look simple. Some of the factors and their interactions can be characterized now and can be used in predicting wetland response. But others have uncertainty that needs to be addressed. This poster provides insight into what we know and do not know about how coastal wetlands currently respond to sea-level rise and how this response may be altered in the future.

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GREEN TURTLES THAT “DIG” FOR DINNIN AND SEAGRASS COLLAPSE?

Desertification due to intensive grazing is described for many ecosystems. An increasing number of studies demonstrate that degradation of those systems is not only dependent on herbivore density but also on abiotic factors hampering plant recovery. For a relatively simple seagrass-grazer (Halodule uninevris - green turtle, Chelonia mydas) system, we introduce a newly discovered destructive grazing strategy “digging” of an exceptionally dense green turtle population. Surprisingly green turtles not only graze on leaves but also “dig” for roots and rhizomes and thereby initiate a spatial “leopard” pattern of gaps in seagrass meadows. Using broad-scale long-term observational data we show that the green turtle density and digging intensity are increasing. Data from experimental gap clearings showed that decreased regrowth and increased erosion are the major explaining factors hampering recovery. By using a fully parameterised predator-prey model, we show that a mismatch between seagrass regrowth, erosion stress and grazing (“digging”) pressure potentially leads to alternative stable states, which amplify the likelihood of an irreversible collapse of vital seagrass meadows. We furthermore discuss the possible strategies for conservation strategies to avoid, or navigate away from undesirable phase-shifts.

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ESTUARINE BIOTOPE MOSAICS AND GOALS FOR HABITAT MANAGEMENT: AN APPLICATION IN TAMPA BAY

Many forms of anthropogenic stress to estuaries can result in destruction and conversion of habitats, thus altering habitat landscapes and changing the “arena” in which the life history interactions of native fauna take place. This can result in decreased populations of valued fauna and other negative consequences. The Tampa Bay Estuary Program pioneered a system-wide management framework that develops estuarine habitat restoration and protection goals based on supporting estuarine-dependent species and the habitat landscapes they require (for example, the extent of seagrass beds, mangrove forests, oyster reefs, or oligohaline marshes) within an estuary. We describe this framework, and we provide related statistics as methods to help managers set system-wide ecological goals using larger conceptual approaches that are easily communicated to stakeholders and the public. We also discuss applications of the approach to existing and evolving paradigms of estuarine management. The Tampa Bay Estuary Program and partners used this framework to combine a simple and unifying stakeholder vision with a diverse and complex set of management tools, resulting in greatly improved environmental conditions in Tampa Bay.

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THE EFFECT OF DIET-CYCLING HYPOXIA ON EASTERN OYSTER (CRASSOSTRANA VIRGINICA) CLEARANCE

Oysters in shallow water can be exposed to oxygen concentrations that fluctuate between hypoxic and super-saturated conditions on a day-night cycle. To assess the effect of diel-cycling hypoxia on clearance rates of Crassostrea virginica, oysters in two size ranges were placed in tanks on a flow-through system and exposed to three different cycling oxygen treatments. Two of these cycles mimicked the low nightly dissolved oxygen (DO) concentrations experienced in shallow waters, and consisted of gradually dropping DO concentrations to 1.5 or 0.5 mg/L, holding those concentrations for three hours, and gradually raising them to normoxia again. The third treatment continuously held DO concentrations at normoxic levels. Oyster clearance rates calculated from in vivo fluorescence and flow rates were similar across all three treatments immediately before DO concentrations were dropped and shortly after DO concentrations returned to normoxia. Oysters exposed to the 5 mg/L diel-cycling hypoxia treatment cleared significantly less chlorophyll a than those in the other treatments while the DO levels were held at the 5 mg/L target concentration. These findings indicate that oysters respond to diel-cycling hypoxia by reducing feeding during periods of low DO but feeding rates quickly recover following short exposures to hypoxia.

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EFFECTS OF INVASIVE LIMONIUM RAMOSISSIMUM ON NATIVE SALT MARSH COMMUNITIES IN A CHANGING ENVIRONMENT

Limonium ramosissimum, Algerian sea lavender, is an established invader in southern California marshes that is forming monotypic stands in the middle to high elevations of a number of marshes in the San Francisco Bay Estuary. L. ramosissimum’s high salinity tolerance, reproductive rate, and dispersal suggest potential for spread in the Estuary, and understanding of its interactions with native species and effects on ecosystem function is needed. In this project, we are assessing how invasion by L. ramosissimum affects ecosystem functions, and how anthropogenic changes may further affect these interactions. At two salt marshes in South San Francisco Bay we established plots of L. ramosissimum, and a native plant, L. ramosissimum, at two elevations (levels of inundation) as a proxy for sea level rise. To simulate anthropogenic nutrient enrichment, we added nitrogen (N) fertilizer every two weeks during the growing season. Early results indicate that at both marshes, Coyote Point and Sanchez marsh, there was an increase in canopy height in correlation with nutrient addition, but L. ramosissimum canopies were still significantly shorter than L. ramosissimum. In field observations our native indicator for L. ramosissimum habitat preference is L. ramosissimum. Additional study with stable isotope tracers, evaluation of native amphipod and other insect species use, and decomposition rates will help to further establish ecosystem changes occurring as result of the invasion. This will also help us assess any further anthropogenic induced modifications on ecosystem changes.

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WHAT INFORMATION IS CONTAINED IN PHYTOPLANKTON TIME SERIES, AND HOW CAN IT BE EXTRACTED?

Scientific investigations and monitoring programs are recording changes in phytoplankton biomass and/or community composition in estuarine-coastal ecosystems around the world. Many of these records have now been sustained for multiple decades. Each of these records contains rich information about patterns of variability, and the challenge now is to determine how those patterns can be used to identify underlying processes of variability. For example, is it possible to extract signals of climate change from phytoplankton time series at the land-sea interface where other drivers of change operate at the same time? What techniques are available for extracting information from time series (see http://cran.r-project.org/web/packages/wq/)? What are the important components of variability and do these vary across ecosystems? Does phytoplankton variability in estuarine-coastal waters follow the same patterns observed in the ocean or in lakes? Is there regional or global synchrony of phytoplankton changes such as abrupt shifts or trends? Do seasonal patterns change? What international efforts are under way to address these kinds of questions (see http://www.scrii.int/Working_Groups/wg137.htm), and what progress has been made recently (see Estuaries and Coasts, March 2010)? Scientists are filled with questions.

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THE DEEPWATER HORIZON (DWH) OIL SPILL: EFFORTS TO ESTABLISH A BASeline ASSESSMENT AND POTENTIAL CHANGES TO A CRITICAL HABITAT, OYSTER REEFS AND THEIR ASSOCIATED FAUNA ACROSS MULTIPLE FLORIDA GULF ESTUARIES

Oysters (Crassostrea virginica) is an abundant natural resource of considerable importance throughout the Gulf of Mexico, producing extensive reef habitats that include “reef flats” (occurring intertidal and shallow subtidal), intertidal “firing reefs” near marshes or mangroves, and on red mangrove prop roots and submerged deeper reefs. Although research has shown that oysters provide critical biogenic habitat, most sites in the Gulf of Mexico lack detailed quantitative data on population demographics and the biologically-diverse associated communities. Available historical data also were collected using many different methodologies, often with little or no replication. Baseline data are critical to adequately assess potential impacts from discharges related to the Deepwater Horizon spill, related restoration and post-recovery status, as well as as anticipated future stressors such as climate change and demographic shifts. The goal of this two-year oyster focused effort is to assess

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pre-spill conditions at replicate sites in the Florida Panhandle, Tampa Bay area, SW Florida (Pine Island Sound, San Carlos Bay) and South Florida around the Rookery Bay NERR using identical methodologies. In this multidisciplinary and multi-institutional effort, we are assessing 60 natural oyster reefs for multiple metrics: abundance and size, resident reef communities, recruitment onto deployed uniform oyster shell substrates, and growth and survival of deployed caged oysters (~40 mm). We are also sampling tissues at the above sites and oyster reefs in areas as likely to have been impacted by DWH oil in both PAH concentrations and genetic diversity. We stress how important collecting baseline C. virginica data are to assessing the magnitude of any oil-related impacts. We discuss preliminary results to date and potential implications for future stressor events.

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THE UPPER SAN FRANCISCO ESTUARY

Phytoplankton production is the dominant source of organic matter to the foodweb of the low salinity zone (LSZ) of the San Francisco Estuary. In addition to local production, organic carbon from phytoplankton also enters the LSZ from rivers and more saline regions of the estuary. Transported phytoplankton arriving intact can support higher trophic levels directly through the grazer food web. Alternatively, phytoplankton adapted to either higher salinities or freshwater conditions advected into the LSZ can become damaged due to osmotic stress. Degraded phytoplankton release dissolved organic carbon (DOC), potentially increasing bacterial production and enhancing the microbial loop. Experiments were conducted to determine the effects of salinity on phytoplankton and bacterial biomass in the LSZ to begin to assess pathways of organic matter flow among lower trophic levels. Phytoplankton assemblages from either 0 or 5 psu were exposed to a range of salinities encountered in the LSZ for up to 12 h. At multiple time points DOC, chlorophyll a, and bacterial biomass and production were determined. Phytoplankton biomass was maintained at salinities to which phytoplankton were adapted (0 or 5 psu), and generally declined as salinity either increased or decreased respectively. As phytoplankton biomass decreased, bacterial production increased, likely due to production of DOC associated with phytoplankton degradation. These findings indicate that organic matter supplied to the LSZ through transported phytoplankton may be processed by the microbial loop, and result in lower foodweb efficiency.

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MULTIPLE STRESS LEVEL EFFECTS ON THE INTERACTION OF SALT MARSHP SPECIES ON MAGROVE SPECIES

The Stress Gradient Hypothesis (SGH) predicts the dominance of either competitive or facilitative effects of a neighbor plant on a target plant in a particular stress context. The Revised Stress Gradient Hypothesis expands on the basic SGH by including the life history type and stress gradient type. This study tests the predictions of two of these hypothesis as well as the effects of multiple co-occurring stress gradients in a mangrove and salt marsh system using Structural Equation Models based on both the original and revised SGH to predict the effect of salt marsh species on mangrove species under several stress gradients (e.g., salinity, light, elevation, sediment type, nutrients, temperature, and latitude) for data collected in an observational survey throughout Florida. This project focuses on the latitudinal portion where mangrove and salt marsh systems overlap: southern Florida where mangrove species are dominant to northern Florida where salt marsh species are dominant with mangroves occurring only in rare isolated patches. Our previous studies have found that salt marsh species have a strong positive effect on initial recruitment of mangrove species regardless of stress context but the effect on early growth depends on the level of stress with later growth of mangroves being hindered by salt marsh presence.

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TRAINING THE NEXT GENERATION OF OCEANS AND HUMAN HEALTH SCIENTISTS

Oceans and human health (OHH) is an emerging discipline, which brings together practitioners from diverse fields to promote a better understanding of the connections between ocean health and human health. Resource management agencies have long studied how human activities affect the health and productivity of our oceans, but only recently has there been growing awareness of the direct and indirect effects of the state of ocean ecosystems on human health and wellbeing. In 2007, NOAA’s OHH program funded five Consortia for Graduate Training in OHH, to promote cross-disciplinary education and training in this important area. In this session we have invited the students, graduates, mentors, and PIs to present the results of their research that has been conducted under the OHH training grants. We will also hear about OHH-related research being conducted outside of the program. Students and young scientists at the meeting are especially encouraged to attend this session and be part of this growing research enterprise. The specific goals of NOAA’s OHH program are to 1) develop and improve early warning systems to forecast human health threats from U.S. coastal and Great Lakes waters, 2) investigate and optimize health benefits from the sea, and 3) foster a robust and multi-disciplinary OHH community to improve public health. Research being conducted under the training grants is centered on these goals and includes studies on mangrove ecosystems,衡量, harmful algal blooms and their toxins, chemical contaminants, sentinel species in the coastal oceans and Great Lakes, and the impacts of climate variation and change on ocean-related threats to human health. This introductory presentation will highlight how these investigations have been, or will be, used to improve public health decision making. Examples will be given that demonstrate the unique achievements that can arise from multi-disciplinary approaches in support of a common goal.
IN SITU NITRATE MEASUREMENTS AND NEW PRODUCTIVITY IN CENTRAL LONG ISLAND SOUND

Biogeochemical cycles in estuaries are controlled by a diverse set of physical and biological variables that operate over a variety of time scales. Using in situ optical sensors, we conducted a high-frequency time-series study of several biogeochemical parameters at a mooring in central Long Island Sound. Overall nitrate concentrations remained low in surface waters throughout the period, reflecting summertime stratification typical of Long Island Sound. We documented well-defined diel cycles in nitrate concentration that were correlated to dissolved oxygen, wind stress, tidal mixing, and measurements of available radiation. Less frequent physical forcings, including large-magnitude wind events and spring tides, served to decouple the photosynthetic relationship between oxygen, nitrate, and sunlight on about one-third of study days. Changes in nitrate concentrations on days without significant decoupling were used to generate daily estimates of new primary production, the first of their kind in Long Island Sound. These values were compared to estimates of total gross productivity, which were derived from in situ measurements of oxygen concentration. Daytime nitrate minima and dissolved oxygen maxima occurred nearly simultaneously on the majority (> 80%) of days during the study period; both were strongly correlated with the daily peak in photosynthetically active radiation. Nighttime nitrate maxima reflected a pattern in which surface-layer stocks were depleted each afternoon and recharged the following night. To examine the effects of wind forcing and wave action on nitrate entrainment, we filtered the data to remove the dominant diel signal. During two storm events, we observed a sharp increase in nitrate concentration soon after storm onset, presumably entrained from nutrient-rich water below the summer thermocline. This pulse was followed rapidly by a drawdown to nearly 0 μM as the newly available nutrient material was rapidly incorporated by primary producers.

SEAGRASS FORAMINIFERA OF FLORIDA BAY: PROXY FOR WATER QUALITY THROUGH TIME

Seagrass abundance is well correlated with water quality. Evaluating the effects of anthropogenic vs. natural events on water quality helps environmental efforts in setting restoration goals. We compared changes in a proxy for seagrass abundance with the timing of these events as recorded in 200 samples from 6 sediment cores. The proxy PSAF, percentage of seagrass-associated foraminifera, was based on benthic species that are more abundant on seagrass than in sediments. To test the seagrass proxy, we examined 1970–2001 values (±2 yr) in relation to the Bay’s 1987–1994 great seagrass dieoff that caused sediment resuspension, phytoplankton blooms and decline in water clarity. Lows in all cores 1984–1994 correspond with net oxygen minimums, and PSASF increased significantly with net oxygen. After 1970, when more frequent monitoring was initiated, the extent of hypoxia has increased with discharges of nutrients from land and atmosphere over the last century, although there are only few studies quantitatively supporting this. Oxygen monitoring data from the beginning of the 1990s suggest that hypoxia is confined to the very deep parts of the Bay, but the scarcity and heterogeneity of data complicates the assessment of hypoxia. After 1970, when more frequent monitoring was initiated, the extent of hypoxia has increased with discharges of nutrients from land and atmosphere over the last century, although there are only a few studies quantitatively supporting this. Oxygen monitoring data from the beginning of the 1990s suggest that hypoxia is confined to the very deep parts of the Bay, but the scarcity and heterogeneity of data complicates the assessment of hypoxia.

EVALUATION OF SIZE AND ABUNDANCE-BASED METRICS OF ESTUARINE FISH COMMUNITIES FOR ECOSYSTEM MANAGEMENT

Metrics based on size and abundance (SAMs) of fish communities are sensitive to the effects of fishing in large marine ecosystems and are potentially useful tools for ecosystem management. SAMs are not species dependent, which allows comparisons of responses to stresses among and within ecosystems. However, these metrics are unvalidated at temporal and spatial scales relevant for assessment of estuarine ecosystems. We analyzed SAMs at seasonal, annual, and decadal time scales in Chesapeake Bay and Pamlico Sound at spatial scales < 50 km and 50-100 km. Because of the ecological and economic importance of individual species, principle component analysis (PCA) of species spatio-temporal data was used to relate temporal and spatial changes in species composition of the fish communities to observed SAMs patterns. Recruitment variability of anadromous and estuarine fishes was successfully tracked by SAMs across seasons and years at spatial scales of 40-50 km in Chesapeake Bay. Species generating variability in the SAMs at these temporal and spatial scales were elucidated by PCA. At 50-100 km spatial scales, significant trends in SAMs were detected in a 13-yr time series of fish community data in the lower Chesapeake Bay.
HUMANS IN THE ECOSYSTEM: UNINTENDED ADVERSE CONSEQUENCES OF IMPROVING WATER QUALITY IN ESTUARIES

Estuaries are an interface between terrestrial and marine systems that are exposed to multiple human activities, which can affect the quality of estuarine waters. Estuarine health is most often monitored using physico-chemical indicators, which are useful for evaluating nutrient cycles and water quality. However, these indicators may not reflect the biological health of the estuary, which is determined by the health of the ecosystem. The importance of ecosystem-based management and the need for a comprehensive approach to estuarine management is highlighted in the context of the National Oceanic and Atmospheric Administration (NOAA) Office of Estuarine Research and Restoration (OERR) and the National Estuarine Research Reserve System (NERRS) program. The OERR program is a federal initiative that promotes the protection and restoration of estuarine ecosystems, and the NERRS program is a network of 28 estuarine research reserves that support research, education, and outreach activities. The OERR program is funded by the NOAA Office of Ocean and Coastal Management (OCM) and the National Marine Fisheries Service (NMFS), and its mission is to support the conservation and enhancement of estuarine ecosystems, and the NERRS program is a network of 28 estuarine research reserves that support research, education, and outreach activities. The OERR program is funded by the NOAA Office of Ocean and Coastal Management (OCM) and the National Marine Fisheries Service (NMFS), and its mission is to support the conservation and enhancement of estuarine ecosystems.
The simultaneous measurement of CO2 uptake and O2 production in aquatic ecosystems is not a method that has taken hold among phytoplankton ecologists or physiologists. IRGA coupling between CO2 and O2 fluxes. Here we employ infrared gas analyzers (IRGA) to validate simultaneous IRGA-based measurements of CO2 uptake and O2 production in phytoplankton cultures. The objective of this study was to understand processes controlling elevation change in mangrove systems by analyzing relationships among mangrove both soil surface accretion and belowground biomass. We consider CO2 and O2 fluxes obtained with IRGA to standard measures of community production, based on O2 evolution, and primary production, based on 14C-uptake, O2 uptake and O2 production in phytoplankton cultures. We compare CO2 and O2 fluxes obtained with IRGA to standard measures of community production, based on O2 evolution, and primary production, based on 14C-uptake, among a diverse array of taxa. For the IRGA technique, known concentrations of CO2 and O2 were injected into cultures, which were subsequently sealed for incubation periods varying in length depending on culture densities. Final gas concentrations in the headspace of culture vessels were sampled and injected into CO2 and O2 analyzers. Measurements were made on Dunaliella tertiolecta, Melosira octogona, Nannochloropsis salina and Rhodomonas salina, in log and stationary phases across a range of cell densities (10 to 9000 cells per ml) and biovolumes (20,000 to 130,000 cubic microns per microliter). There were strong linear relationships between traditional measures of productivity and fluxes of CO2 and O2. The relationships between community production calculated from O2 fluxes measured by IRGA, community production based on traditional O2 evolution, and 14C uptake approached unity. Despite the application of IRGA to studies of phytoplankton metabolism in the 1980s, it may present an inexpensive alternative to mass spectrometers, which are often used for simultaneous measurements of gas fluxes.

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SALT MARSH PRODUCTIVITY AND PHENOLOGY IN A CHANGING CLIMATE: THE IMPORTANCE OF RESOURCE ALLOCATION IN SPARTINA ALTERNIFLORA

In the context of a changing climate and rising sea levels, the fate of salt marshes is uncertain. In order to determine the potential for persistence of these valuable coastal ecosystems with global change, it is essential to consider both large-scale trends in productivity and the potential for population-level changes in resource allocation. Within Spartina alterniflora-dominated systems, marsh elevation is maintained by a combination of above and belowground biomass accumulation, which capture suspended sediment and build peat, respectively. How marshes will be maintained in the future will be determined in part by changes to the relative amount of growth resources allocated above and belowground, and thus understanding the controls on resource allocation in essential. Additionally, climate and environmentally-driven changes to S. alterniflora phenology, particularly the timing of flowering, may impact productivity and biomass allocation on local to latitudinal scales. Using eight sites between Massachusetts and South Carolina, drivers of resource allocation and flowering phenology were investigated through a combination of experimental and observational approaches. A reciprocal transplant across sites arrayed on the latitudinal gradient indicated that plants from northern marshes performed poorly in the current southern climatic regime. Phenological evidence from a common garden experiment provides additional insight into S. alterniflora responses to changing climate. It is essential to consider both the relative importance of phenotypic plasticity and local adaptation in this salt marsh foundation species in order to predict future changes to marshes and the ecosystem services they provide.

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MITIGATION OF ESTUARINE EUTROPHICATION BY AQUATIC HABITAT RESTORATION?

The cost, both financial and political, of limiting nutrient inputs to impaired water bodies has led to examination of alternative management alternatives for 1) intercepting N and P before reaching the tidal estuary and 2) altering the fate of N and P within the estuary. In this presentation, we will examine the potential for positively altering N and P cycling pathways in eutrophic estuaries by restoring wetland and oyster habitats. The key questions are 1) what is the nutrient removal potential of restoration per square meter of restoration, 2) how much restored habitat is necessary to achieve Chesapeake Bay’s 10% nutrient reduction goal, and 3) how realistic is it to achieve the required area. Using new data on nutrient assimilation and dissimilation (denitrification) in Chesapeake Bay oyster reefs and a summary of Chesapeake and mid-Atlantic wetland N burial, P burial and denitrification rates, we will evaluate the realistic potential of achieving an important level of nutrient reduction via restoration. The strengths and weaknesses of current data sets will be identified and the likelihood of success using these approaches will be discussed.

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THE ROLE OF BIOTIC PROCESSES ON SOIL ACkREATION AND ELEVATION CHANGE IN MANGROVE FORESTS IN SOUTH FLORIDA

Sediment surface elevation is a critical factor affecting wetland structure and function, especially in environments with tidal influence, such as that of Florida Bay and adjacent mangrove wetlands. If elevation cannot keep pace with sea level rise, progressive waterlogging, plant death, erosion, and subsersion results in wetland loss. In addition, little information exists on how soil formation may be affected by changes in freshwater flow and nutrient input once the Comprehensive Everglades Restoration Plan is in place. The objective of this study was to understand processes controlling elevation change in mangrove systems by analyzing relationships among mangrove both soil surface accretion and elevation change, and physical and biological characteristics, such as above and belowground processes, soil organic matter, and bulk density. We tested the hypothesis that elevation change and soil accretion patterns are controlled by spatial and temporal variability of belowground processes, which on turn are driven by environmental factors including sediment input, hydroperiod, soil salinity and soil nutrients. Results showed that belowground biomass varied significantly among sites ranging from 357 to 3117 g m-2.
Root productivity (<10 mm root diameter) ranged from 407 to 643 g m-2 yr-1 with higher rates in Shark River compared to Taylor River. Accretion results show that average vertical accretion was higher at Shark River than at Taylor River (6.6 mm yr-1 and 3.9 mm yr-1, respectively). Over the ten-year long study period, elevation change has been very small, averaging 8.8 mm yr-1 in Shark River and 1.2 mm yr-1 in Taylor River. These rates of elevation gain or loss and biotic processes suggest that mangrove forests associated to sediment input from the Gulf of Mexico may be able to keep pace with the predicted accelerated sea level rise. In contrast, mangrove forests associated to Northern Florida Bay may not be able to keep pace with increase sea level rise.

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

Time series of hourly data on fluorescence were collected at the entrance of the Patos lagoon. 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 deployed in the main channel together with two Seabird 37SM thermo-conductivimeters that were measuring salinity and temperature at the surface and bottom (10 m). Near this area a SonTek Argonaut acoustic Doppler current profiler was moored to produce hourly profiles of current velocity and direction. 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. However the intensity of the peak depends on river discharge that acts on the flushing time of the area. Two main patterns have been observed: a) a chlorophyll a peak that has no lag with respect to flood currents and salinity being tied to resuspension and; b) an initial peak that increases as the salty water remains longer in the inner estuarine area. When seaward flow dominates chlorophyll a concentrations remain low for a long period of time. This analyzes indicate that most of the chlorophyll a variability results from different flows intensity and direction of transporting coastal waters in and out of the lagoon.

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PATTERNS FOR PRIMARY PRODUCTION IN HIGH AND LOW MARSH COMMUNITIES ACROSS MULTIPLE SCALE

Patterns and controls of Spartina alterniflora production in low marshes are better known than for high marshes and their species. High marshes are less frequently flooded by tidal waters and often have more organic soils and higher standing stocks of dead material. We have assessed the patterns of saltmarsh above-ground primary production at the Virginia Coast Reserve Long-Term Ecological Research site. Specifically we evaluated similarities in inter-annual patterns of above-ground production among multiple marshes for both low and high marsh communities. As many as 11 yr of end-of-season aboveground plant biomass data were collected in numerous marshes on the Delmarva Peninsula. Here we focus on both high and low marshes that were simultaneously harvested over at least a 10 yr period at 7 sites. The marsh sites extend for approximately 35 km from north to south. Considerable variation existed for EOYB between communities and among marshes for any year. Variation was, also, high among years for each marsh community. However, the mean annual live EOYB standing stocks of low and high marshes were similar to one another when results from all marshes were combined. The total EOYB for high marshes were greater than for low marshes as a result of carryover of previous standing dead. Further, low and high marsh EOYB tracked one another from one year to the next when all marshes were averaged. We infer that despite local environmental differences between communities and among sites, large scale factors are controlling annual above-ground production of both communities in comparable ways.

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REGIONAL ANALYSIS OF WATERSHED NITROGEN MANAGEMENT OPTIONS FOR IMPROVING COASTAL ESTUARINE HEALTH

Anthropogenic activities are the largest contributing source of nutrients to watersheds, which ultimately drain to coastal estuaries. Nutrient loading, particularly nitrogen (N), is strongly linked to the occurrence of eutrophic conditions in coastal estuaries. In this study the potential for reducing anthropogenic N inputs was quantified using N source reduction values reported in peer-reviewed literature for a variety of management strategies, ranging from technological to behavioral. The Net Anthropogenic Nitrogen Inputs (NANI) model was used to establish baseline N input values for watersheds that correspond to coastal estuaries. The NANI model was modified to approximate decreased loading as a result of implementing selected mitigation strategies. Empirically-derived relationships between land-based N loading and flux to coastal estuaries were used to estimate N loading to coastal estuaries in both baseline and mitigation scenarios. Anthropogenic N input categories include: fertilizer (agricultural and residential), N fixation associated with select crops, atmospheric deposition, and consumption of N through food/feed by humans and livestock. Mitigation strategies range from technological, e.g., nitrous oxide emission controls, precision fertilizer application, wastewater treatment controls, to behavioral, e.g., reductions in residential fertilizer application, fossil fuel conservation, dietary shifts. Results indicate that many reduction strategies are available that could be very effective for improving estuarine health. Further, N loading was associated with estuarine health evaluations determined by the 2007 National Estuarine Eutrophication Assessment in an effort to identify areas where action may be most effective. Effective polices should consider both the national importance of addressing N and will also include flexibility so that region-specific approaches are permitted.

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LAND AREA CHANGE IN COASTAL LOUISIANA FROM 1932 TO 2010

Coastal Louisiana wetlands make up the seventh largest delta on Earth, contain about 37 percent of the estuarine herbaceous marshes in the contiguous United States, and support the largest commercial fishery in the lower 48 States. These wetlands are in peril because Louisiana currently undergoes about 90 percent of the total coastal wetland loss in the continental United States. Documenting and understanding the occurrence and rates of wetland loss are necessary for effective planning, protection, and restoration activities. The analyses of landscape change presented here used historical surveys, aerial data, and satellite data to track landscape changes. Summary data are presented for 1932–2010; trend data are presented for 1985–2010. These later data were calculated separately because of concerns over the comparability of the 1932 and 1956 datasets (which are based on survey and aerial data, respectively) with the later 5 datasets (which are all based on satellite imagery). These analyses show that coastal Louisiana has undergone a net change in land area of about -1,883 square miles (-4,877 square kilometers) from 1932 to 2010. This net change in land area amounts to a decrease of about 25 percent of the 1932 land area. Persistent losses account for 95 percent of this land area decrease; the remainder are areas that have converted to water but have not yet exhibited the persistence necessary to be classified as “lost.” Trend analyses from 1985 to 2010 show a wetland loss rate of 16.6 square miles (42.9 square kilometers) per year. If this loss were to occur at a constant rate, it would equate to Louisiana losing an area the size of one football field per hour. The use of 17 datasets plus the application of consistent change criteria in this study provide 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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The northwestern Gulf of Mexico currently experiences a large hypoxic area ("dead zone") during the summer. While local effects of the hypoxia are documented, the population-level effects are largely unknown. We developed a spatially-explicit, individual-based model to analyze how hypoxia effects on vital rates (fecundity, growth, and mortality) could lead to population-level responses. The model followed the hourly growth, mortality, reproduction, and movement of individuals for 100 years. A 1-km resolution grid was used representing an offshore box where spawning occurs and two nursery areas (Texas and Louisiana) nearshore and estuarine habitats. Food (represented by chlorophyll-a) and water temperature were specified daily for each grid cell for an average year, which was repeated every year. Dissolved oxygen was specified hourly for each grid cell, with three hypoxia scenarios (mild, moderate, and severe). A bioenergetics model represented growth, mortality was assumed stage-dependent, and movement was modeled as kinesis plus avoidance behavior. A fourth scenario was random time sequences of mild, moderate, and severe hypoxia years based on their frequency of occurrence in field data. Hypoxia effects were imposed using vitality-repair submodels that assess growth, reproductive potential, and survival based upon the exposure history of each individual. Simulations resulted in small reductions in the mean adult population abundance for the mild and moderate conditions repeated every year (<10%), but a large reduction (about 30%) under the severe hypoxia condition. Time series scenario simulations resulted in 15-25% reductions. Sensitivity analysis showed the importance of avoidance behavior to determining the population response. We discuss the strengths and weaknesses of trying to predict population-level effects from individual behavioral responses, and future plans for refining the analysis based on data from ongoing field and laboratory studies.

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SEA-LEVEL CHANGE: PATTERNS, PROCESSES AND IMPACTS

Sea-level rise (SLR) is among the most important societal issues related to climate change, yet it is also one of the most misunderstood in both scientific and public circles. This is due in part to the multidisciplinary nature of sea-level research, which attracts experts in glaciology, oceanography, geology, geomorphology, climate modeling, coastal ecosystems, and coastal management and engineering who rarely interact with one another. Yet several themes have emerged during the past few years that are important to all in the coastal and estuarine community. Among them: Evidence indicates that rates of SLR can vary greatly, from less than 1 mm/yr to greater than 50 mm/yr, and that future rates will probably exceed the current 3 mm/yr, perhaps by several times. Although focus has been on global SLR rates, it is now recognized that SLR rates for any particular coastal region vary over multiple timescales ranging from millennial (glacioisostatic adjustment) to decadal (ocean-atmosphere dynamics) timescales. Integrating instrumental and paleo-sea-level reconstructions remains an underexploited field of research relevant to multidiscadal sea-level oscillations. New discoveries about glacier and ice sheet dynamics suggesting a growing contribution to modern SLR from melting ice will also help explain past sea-level changes. We will introduce several common goals surrounding sea-level research: providing a realistic, state-of-the-art assessment of how fast sea level has risen in the past and how fast it will rise in the future, quantifying factors that will contribute to sea-level rise, and characterizing the potential impacts. Topics will include rates of sea-level rise during past and present climatic warming, vulnerable coastal systems, non-eustatic processes (isostatic adjustment, subsidence, sediment flux, etc), and regional sea-level changes.

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RATES OF SEA-LEVEL RISE DURING CLIMATIC WARMING

Sea-level rise (SLR) ranks high on the list of climate change issues due to obvious potential threats to coastal regions. Current understanding based on tide gauges and satellite records holds that mean SLR rates were 0.6 mm/yr and 1.9 mm/yr during the 19th and 20th centuries, respectively, 1.7 ± 0.3 mm/yr since 1950 (total ~10 cm), and 3.3 ± 0.4 mm/yr from 1993 to 2009 (total ~5 cm). The idea that sea level was stable prior to an acceleration beginning ~1850-1900 has become widely accepted and that past and projected future periods of climatic warming and constructing a provisional 2000-yr regional sea-level curve for the western North Atlantic Ocean derived from proxy sea-surface temperature (SST) reconstructions. Results show that pre-anthropogenic multi-decadal rates of sea level rise during the MCA and 15th century were 2 to 8 mm/yr.

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NEW TECHNIQUES AND COLLABORATIONS TO RESTORE SEAGRASS IN TAMPA BAY, FLORIDA: A CASE STUDY ON LONGSHORE BAR CREATION

The Tampa Bay Estuary Program (TBEP) partnered with the Tampa Port Authority (TPA) and others to construct an innovative solution for restoring seagrass in Tampa Bay, FL. While seagrass coverage in Tampa Bay has increased in recent decades to the highest recorded coverage since the 1950s, due primarily to improved water quality, recovery lags in certain areas. Longshore bars – sandbars that run parallel to the shoreline – also decreased by nearly half the total length between the 1950s and 1990s. In many locations, seagrasses grow in front of and behind longshore bars. Seaward seagrass rhizomes may stabilize sediments and the bar formation and the bar, in turn, dissipates wave energy for landward seagrass. As a new technique for restoring seagrass, the TBEP/TPA team constructed an artificial 950-foot-long bar system in an area that historically had a longshore bar. The system includes four material types: a sand bar covered with rock, rip-rap, oyster reef balls; and highway jersey barriers. The team utilized materials not typically used in habitat creation, such as out-of-service jersey barriers, and expanded beneficial uses of dredged material. The collaboration with TPA was a new and invaluable partnership for TBEP. TPA provided construction management, significant funding and in-kind support. The bar system is expected to provide beneficial fish habitat due to oyster colonization on the structures. While not an original project objective, the creation of fish habitat has allowed TPA to use the project as mitigation for future dredging activities that will impact fish habitat. The project team will monitor the system for three years to determine which technique is most durable and whether the entire bar feature fosters seagrass recovery. The team hopes to restore ~1.5 acres via recruitment after three years. If successful, re-creation of bar systems may be a useful technique for restoring seagrass in appropriate locations in Tampa Bay and other coastal areas.

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TSUNAMIS UNLIKELY TO IMPACT COAST OF FLORIDA

Tsunamis, a series of ocean waves caused by the sudden displacement of the water column, can have deadly consequences, as witnessed with recent tsunamis in Japan. These powerful waves most often occur in areas with large fault lines, such as the Pacific and Indian oceans, although tsunamis can occur at any time on any ocean coastline. Underwater seismic activity and shifting of tectonic plates can trigger earthquakes, landslides or volcanic eruptions. This produces a series of high energy waves, radiating outward from the source and potentially traveling hundreds of miles to distant coastlines. While the State of Florida is particularly susceptible to hurricanes, it is unlikely it would be hit by a massive tsunami. Historically, few tsunamis have impacted Florida. An 8.8 magnitude earthquake in Portugal in 1775 launched a large tsunami that hit the east coast of the US, although effects in Florida are unknown. An 1886 earthquake in Charleston, SC may have triggered a submarine landslide in Jacksonville that led to tsunami effects in Mayport. Finally, an 18-foot wave hit Daytona Beach on July 3, 1992, likely due to an undershear avalanche. Most agencies involved with tsunami detection and research categorize Florida's risk as low. Nevertheless, it is important that coastal communities and residents are prepared. All 29 US coastal states are partners in the National Tsunami Hazard Mitigation Program. The National Oceanic and Atmospheric Administration has provided useful techniques for restoring seagrass in appropriate locations in Tampa Bay and other coastal areas.
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SEASONAL AND SPATIAL PATTERNS OF BACTERIOPLANKTON COMMUNITY COMPOSITION ACROSS ENVIROMENTAL GRADIENTS IN CHESAPEAKE BAY

Bacterioplankton are essential components of aquatic ecosystems, catalyzing critical biogeochemical reactions and serving as central members of microbial food webs. Communities of these organisms are extremely diverse and highly dynamic, but several recent studies from freshwater and ocean environments show predictable temporal patterns in bacterial diversity on time scales ranging from days to years. There is some evidence of similar temporal patterns in estuaries, but in many estuaries temporal variability in communities is overwhelmed by spatial variability along the strong environmental gradients typical of estuarine environments. This presentation summarizes research on bacterioplankton community composition in three different sub-environments within Chesapeake Bay, each of which exhibits strong environmental gradients: (1) the oligohaline upper Bay estuarine turbidity maximum region, which experiences strong gradients in salinity and turbidity, (2) the mesohaline mid-Bay region, which experiences strong gradients in oxygen concentration, and (3) the many shallow sub-estuaries of the Bay, which experience strong gradients in watershed land use. Our sample set comprises nearly 1200 samples analyzed with PCR-based community fingerprinting techniques, including 485 samples analyzed using Tag Pyrosequencing of PCR-amplified 16S rRNA genes. Preliminary results suggest predictable temporal patterns in each separate environment related to seasonal changes in local environmental conditions. This presentation will compare results from these three environments in order to explore the contrast between spatial and temporal variability in estuarine microbial community composition.

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MODUS OPERANDI TO ANALYZE IMPACTS IN URBAN AND PERI-URBAN MANGROVE AREAS

Coastal urbanization and the conversion of mangrove forests to other land uses have caused important reductions in mangrove extent and consequent loss of functions and services along (sub)tropical coasts. The current study proposes techniques to analyze impacts in urban and peri-urban mangrove areas. Examples are presented along the São Paulo coast (Brazil). Time series of aerial photographs and satellite images and monitoring of mangrove forests using permanent plots were applied to detect the evolution of human activities over the years. Color composites were used in digital remote sensing processing techniques, including 16S rRNA gene sequencing. This study helped the analysis of human pressure on urban and peri-urban mangroves along the São Paulo coast, offering reliable estimates and assisting the local and regional coastal management in Brazil, but can also serve as an example to mangrove management elsewhere.

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KEEPING SCIENCE ALIVE: COLLABORATIONS WITH K12 TEACHERS AND MARINE EDUCATORS

Scientists can be engaged in the K-12 activities by collaborating with educators. Ocean literacy concepts can be woven into K-12 activities ranging from animal biology to coastal processes. We will present activities that we have designed as part of collaboration between a Savannah State University scientist and K-12 teachers and marine educators in the community. Grass shrimp provide a model for us to discuss the Ocean Literacy concept of predator-prey dynamics; we explain how a small, commercially unimportant species has a great impact on the food web. Other activities focus on parasites, mollusks, or environmental issues. All activities emphasize mathematics. We encourage students to develop presentation skills by talking to their class or developing a PowerPoint presentation, complete with music and a script.

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DOES THE BOPYRID PARASITE PROBOPYRUS PANDALICOLA AFFECT THE DENSITY, BEHAVIOR, AND REPRODUCTIVE SUCCESS OF THE DAGGERBLADE GRASS SHRIMP PILEAMONETES PUGIO?

The daggerblade grass shrimp Palaemonetes pugio is host to a variety of parasites including the bopyrid isopod Probopyrus pandalicola. This parasite has the potential to reduce shrimp densities because hosts no longer reproduce while infected. Mean parasite prevalence ranged from approximately 1-3% in South Carolina and Georgia estuaries. We have found that there is no effect of the parasite on shrimp behavior or swimming endurance. Instead, shrimp activity was affected by size, tidal stage, and time of day. Furthermore, there was no effect of the parasite on the likelihood of shrimp being eaten by the mummichog Fundulus heteroclitus. Fish ate more active individuals regardless of parasite presence. Recently our research is focusing on the effect of multistressors (shrimp with parasites plus insecticides or coded wire tags) and we have found differences in predation rates, growth, and LC50 values when shrimp are parasitized.

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MEASURING MARSH SURFACE ELEVATION AND SHORELINE CHANGE AT MULTIPLE SPATIAL AND TEMPORAL SCALES IN THE NEW RIVER ESTUARY, NC

In a study conducted in the New River Estuary, NC, we examined vertical changes in marsh surface elevation and horizontal changes in the marsh shoreline over different spatial and temporal scales. Study sites included marshes dominated by Spartina alterniflora and Juncus roemerianus, and included both fringing and interior marshes along an estuarine gradient. Marsh surface elevation change was measured over approximately 1 m plots using Surface Elevation Tables (SETs), and over 500 m2 plots using a wheel-mounted RTK GPS receiver to collect a high density of elevation points using the SET mark as a reference base station. Digital elevation models (DEMs) were constructed for the larger plots and ArcGIS tools were used to calculate change in plot elevation. Shoreline change was determined over decades (1956 – 2004) using aerial photography for the entire estuarine shoreline. Changes in the horizontal position of the calculated 0 m elevation in DEMs along 50-100 m sections of shoreline provided an estimate of shoreline change over 1-2 yr time periods. We found that the relationship between horizontal and vertical changes in the marsh surface varied...
with the physical setting of the site, with sites exposed to higher wave energy experiencing both higher rates of net surface accretion and higher rates of horizontal erosion. In fringing marshes, we found that distance from the shoreline edge affected patterns of marsh elevation change. In non-fringing marshes, surface elevation and seasonal changes in tidal inundation significantly affected SET estimates of marsh surface elevation change. Processes at the marsh edge need to be incorporated into models predicting the response of marshes to storm events and sea level rise.

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BIOLGICAL IMPACTS ON AN INTERTIDAL MUDEFLAT CAUSED BY HUMAN INSTALLATIONS: THE SEINE ESTUARY CASE

Processes at different timescales govern biologic activities of estuarine mudflats. So, the development of diatom algal mats and macrozoobenthic communities on mudflats are controlled by natural parameters but also by human activity. This morphosedimentary and biologic study led since 1997 included in particular two objectives concerning effects of the harbour installations. First of all quantify the evolution of the diatom algal mats extension on the mudflats which increase with their development the stability of the sediment. The second objective was to map macrozoobenthic communities which occupy the mudflat according to an annual scale to obtain information on the evolution of the ecological state of this surface. The sampling strategy is based on low altitude remote sensing coupled to altimetric, grain-size data and biologic analysis acquired on the mudflat surface. Results obtained during these 14 years shows that the evolution of sedimentary dynamic induced by human installations reduced of 80% the extension of diatom algal mats increasing by this fact the biologic study led since 1997 included in particular two objectives concerning effects of the

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ARE BAY CLAMS GOING GREEN? EELGRASS IS THE KEY HABITAT FACTOR STRUCTURING TIDEFLAT BIVALVE POPULATIONS IN TILLAMOOK BAY, OREGON, USA

The Shellfish and Estuarine Habitat Assessment of Coastal Oregon (SEACOR) project conducted a comprehensive study of bay clam populations using a stratified-random design on three major tidalflats in Tillamook Bay, OR. On each flat, we collected clam population data along with habitat characteristics (tideflat, tidal strata, sediment type, and presence and % cover of the eelgrass Zostera marina) to identify patterns in bay clam species composition, abundance, biomass, size, and spatial distribution. Standard parametric and non-parametric statistical analyses combined with non-metric multidimensional scaling show that there are distinct differences in abundance and biomass between tideflats for the four most abundant species studied (Clinocardium nuttalli, Tresus capax, Macoma nasuta, M. inquinata). However, the presence and % cover of eelgrass was the most important environmental factor affecting bay clam species composition, abundance, and biomass. Three of the four species (C. nuttalli, T. capax, M. nasuta) had significantly higher densities and biomass in eelgrass beds relative to unvegetated areas of the tideflats. This was most dramatic for T. capax populations which had densities 3 orders of magnitude greater and biomass 16 times greater within eelgrass beds. In addition, M. inquinata populations were almost exclusively confined within eelgrass habitat. These relationships highlight the need to better understand the interactions between bivalve populations and eelgrass beds in Pacific Northwest (PNW) estuaries.

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POTENTIAL FOR INCREASED NITROGEN REMOVAL BY NATIVE TRIPOD EASTERN OYSTERS

Oyster restoration and aquaculture may benefit coastal ecosystems by remediating the effects of anthropogenically-driven eutrophication through nitrogen (N) sequestration. The magnitude of this ecosystem service, however, has been rarely documented with direct measurements of N assimilation by oysters. The use of tripod oysters in aquaculture may increase bioremediation capacity due to their increased growth rate compared to traditional tripod oysters. To quantify the role of oysters in improving water quality and investigate potential for increased N removal by tripod oysters, this study will compare direct N removal through assimilation through time in juvenile diploid and native half-sibling tripod oysters. 500 diploid and tripod oysters each will be grown in aquaculture cages at two sites in Mobile Bay, Alabama in collaboration with the Mobile Bay Oyster Gardening Program from June through September 2011. Biweekly sampling will include measurements of water parameters and oyster growth and survival. Dry weight, N and carbon content, and stable isotope ratios will be measured in oyster tissues and water samples. To determine the source of assimilated N, we will compare stable isotope ratios in oyster tissues to those in water samples. Oyster aquaculture and restoration efforts will benefit from the quantification of diploid and tripod N removal capacity as a means to better define ecosystem services.

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DECISION-MAKING REGARDING SHORELINE DESIGN AND MANAGEMENT ALONG THE HUDSON RIVER ESTUARY

During the fall of 2010 and spring of 2011, interviews were conducted with experts, consultants, developers, and railroad representatives involved in the management of the Hudson River shoreline, and designs for shoreline stabilization, restoration, and development. The goals of this work are to document whether and how climate change and sea level rise are currently viewed and incorporated into shoreline planning and design along the Hudson; to identify short-term barriers to the adoption of shoreline engineering techniques into the design process; and to identify potential training needs and mechanisms of information sharing among actors in this organizational network. Findings indicate that incorporation of sea level rise and climate change into shoreline planning and design range from non-existent to central, depending upon project goals, timing of design, intended uses, regulatory requirements, funding and available personnel. Barriers to adoption of soft shoreline engineering techniques include intended uses, limited available area, access, knowledge base of designer or engineer, low levels of confidence in the longevity of soft shorelines, and cost or perceived cost of construction and maintenance. The need for training is considered to be universal, but the type and depth of requisite training varies with prior experience, organizational mission or mandate, and specific work on shoreline projects (i.e. design, engineering, construction, landscaping). The Hudson River Estuary is a complex system, ecologically, hydrologically, socially, economically, organizationally, and politically. This complexity presents both opportunities and challenges. One of the basic tenets of resiliency science is redundancy in the system, and this is a pervasive feature of the Hudson River Estuary. It is both possible and desirable to make use of the terrific complexity of the Hudson to meet the goals of the Sustainable Shorelines Project.

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SHADE AND SALT TOLERANCE OF RARE, COMMON AND INVASIVE MANGROVES

One explanation for plant distributions is the trade-off between competitive ability and stress tolerance in plants—poorer competitors can tolerate more stressful environments, resulting in narrower distributions. In groups of species adapted to stressful environments, variation in ability to cope with harsh conditions may have consequences for patterns of distribution: are widespread species more stress-tolerant than narrow endemics? Mangrove forests are an ideal system to test this question, as they provide a physically challenging habitat for plants—the tidal influence results in flooded, hypoxic and saline soils. Mangroves were thought to be resistant to invasion because of their stress tolerant—most plants cannot survive in saline, flooded soils, with high temperatures or low light. However, nonnative mangroves already adapted to these harsh conditions may be able to replace native species. I examined the effects of shade and salt on survival and growth of four mangrove species. I grew seedlings of one rare, two common, and one invasive species in outdoor tubs at the Smithsonian Marine Station in Ft Pierce under varied shade and soil salinity levels. This complexity presents both opportunities and challenges. One of the basic tenets of resiliency science is redundancy in the system, and this is a pervasive feature of the Hudson River Estuary. It is both possible and desirable to make use of the terrific complexity of the Hudson to meet the goals of the Sustainable Shorelines Project.
the most stressful conditions. The rare species, Pelliciera rhizophorae, was intolerant of the most stressful light level and responded to a range of salinity levels. In addition to contributing to our understanding of plant distributions, the results from this study may aid management efforts to control the newly invasive species L. racemosa.

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INFLUENCE OF WATERSHED CHARACTERISTICS ON WETLAND HYDROLOGY (TAMPA, FL)

The availability of oxygen in wetland soils is a major driver of rate changes for several important ecological functions (e.g. nutrient processing, carbon sequestration) that the Tampa Bay Ecosystem Services Research Program (TB-ESRP) is quantifying to estimate ecosystem services. Fluctuating water levels in coastal and riparian wetlands expose soils to differing oxygen regimes which have significant impacts on biogeochemical transformation processes. To better characterize the relationships between hydrology, precipitation and nutrient processing with groundwater level fluctuations, continuous water level data were collected in forested or marsh wetland within landscapes characterized as being either predominantly urban, agricultural or of natural influence. These data are essential for refinement of our dynamic simulation models for predicting wetland flooding/drying cycles to link estimates of biochemical processes to impacts on wetland ecosystem services. Presented are water level fluctuations over a one year period from 27 wetland study sites in the eastern Tampa Bay watershed; relationships between wetland soil denitrification potential, hydrology, and landscape characteristics are explored.

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CLIMATE CHANGE INDUCED ON OVERLAND SEDIMENT TRANSPORT AND WETLAND MORPHOLOGY IN APALACHICOLA BAY, FLORIDA, USA

Global Climate Change (GCC) has been a worldwide most discussed topic not only amongst scientific societies but also various groups of the world population. The GCC by itself is not the focus of our paper, but rather the impacts of GCC on coastal ecosystems is of concern, especially ones that impose threats on humans and our ways of live, animals, and plant species. Coastal zones, rivers, lakes, or other water sources are places where human populations and all other lives are concentrated and flourish. Wetlands are the interfaces of aquatic and terrestrial environments. Wetlands offer productive habitat for various matrices of aquatic and terrestrial species. Humans use wetlands in various ways, directly and indirectly. The geomorphology of a wetland depends greatly on the hydrologic conditions, water quality, plant species, sediment transport, the size and composition of the sediment, tidal and winds forces. Wetlands in the Apalachicola Bay, Florida, are mostly flow-through systems. The outlet conditions in this area are mostly open to the Apalachicola Bay. The wetlands are mainly subjected to the tidal force and upstream flows, which would be the two main components that compel the change of wetlands’ geomorphology in this area. Global Circulation Model (GCM) has estimated that the intensity of future rainfall events will be more extreme. Estimated rainfall Intensity-Duration-Frequency (IDF) values were derived from a down-scaled GCM precipitation. The predicted IDF rainfall intensity of the year 2090 will be used to estimate overland runoff and sediment transport to wetlands in the Apalachicola Bay, Florida. WASH123D is a numerical model that is capable of simulating density-dependent water flow, sediment, and chemical transport in watershed systems. Overland runoff, erosion and sediment transport in the Apalachicola watershed will be simulated using WASH123D based on various rainfall scenarios derived from GCM. Wetland morphology will be discussed.

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EVIDENCE FOR TURTLEGRASS SEED CONSUMPTION BY BLUE CRABS

While seagrass propagation has historically been attributed to asexual rhizomatous growth, recent studies suggest that sexual reproduction (i.e. fruit and seed production) may also play a large role. Consequently, it is necessary to understand factors that limit fruit and seed dispersal and successful seedling recruitment. Fruit and seed consumption by crustaceans can produce a top-down effect on seagrass recruitment potential. We examined consumption by a common crustacean found in South Texas estuaries (blue crabs) on turtlegrass fruits and seeds. A series of laboratory experiments were conducted to quantify the amounts of turtlegrass fruits and seeds eaten over a 24-h period by blue crabs. Blue crabs consumed an average of 14 ± 0.39 g of fruits and 24 ± 0.15 g of seeds of the weight of a single fruit (1.35 ± 0.03 g). However, crabs crushed and partially consumed 72% of offered fruits and often selectively ate the seeds. Crabs ate an average of 0.66 g of seeds, but crushed 70% of offered seeds. There was no difference among crab size classes in amount of fruits or seeds consumed. Results of this study indicate that, in laboratory conditions, blue crabs consume turtlegrass reproductive tissues and likely prefer seeds. Fruit and seed consumption by blue crabs may be an influential top-down effect limiting successful seagrass recruitment. Future studies will incorporate field experiments and a wider variety of potential consumers.

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USE OF COMPUTER-AIDED TOMOGRAPHY (CT) IMAGING FOR QUANTIFYING COARSE ROOTS, RHIZOMES, PEAT, AND PARTICLE DENSITIES IN MARSH SOILS

Computer-aided Tomography (CT) imaging was utilized to quantify wet mass of coarse roots, rhizomes, and peat in cores collected from organic-rich (Jamaica Bay, NY) and mineral (North Inlet, SC) Spartina alterniflora soils. Calibration rods composed of materials with standard densities (i.e., air, water, colloidal silica, and glass) were used to operationally define the specific x-ray attenuations of the coarse roots, rhizomes, and peat in the marsh cores. Image analysis was coupled with the CT images to measure the abundance and diameter of the coarse roots and rhizomes in marsh soils. Significant regression relationships were found between the CT determined wet mass of the coarse roots and rhizomes and the hand sieved dry mass of the coarse roots and rhizomes in both the organic-rich and mineral marsh soils; there was also a significant relationship between the soil percent organic matter and the CT determined peat particle density among organic-rich and mineral soils. In only the mineral soils, there was a significant relationship between the soil percent organic matter and the CT determined peat wet mass. Using CT imaging, significant positive nitrogen fertilization effects on the wet masses of the coarse roots, rhizomes, and peat, and the abundance and diameter of rhizomes were measured in the mineral soils. In contrast, a deteriorating salt marsh island in Jamaica Bay had significantly less mass of coarse roots and rhizomes at depth (10 – 20 cm), and a significantly lower abundance of roots and rhizomes compared with a stable marsh. However, the diameters of the rhizomes in the deteriorating marsh were significantly greater than in the stable marsh. CT imaging is a rapid approach to quantify coarse roots, rhizomes, peat, and soil particle densities in coastal wetlands, but the method is unable at this time to quantify fine roots less than 1 mm in diameter.

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STABLE ISOTOPES REVEAL DIFFERENCES BETWEEN NEARSHORE HABITATS AND SUBESTUARIES FOR RESIDENT CHESAPEAKE BAY FISHES

To understand if shoreline modification affects trophic positioning of key estuarine species, we analyzed values of δ13C and δ15N in tissues of three ecologically and economically important species common throughout the mid-Atlantic. We studied two shallow-water resident forage fishes, the mummichog Fundulus heteroclitus and Atlantic silverfish Maryland Chesapeake Bay subestuaries that differ in predominant watershed land use (agricultural, developed, and forested). Delta 13C and δ15N content of mummichog and Atlantic silverfish differed by shoreline and subestuary types. Delta 15N signature of fish in the agricultural and developed subestuaries was higher than the forested subestuary, which may indicate enrichment of N entering from developed and agricultural landscapes. Subestuary effects were especially strong for silverside, a pelagic feeder, whereas effects of immediate nearshore habitat on 13C and 15N values were more apparent for the mummichog, a benthic-oriented feeder. Delta 15N values were lower for mummichog than silverside in all habitats. Since some signatures of fish tissues integrate longer-term foodweb conditions and diet, our analyses demonstrate impacts of shoreline modification on estuarine foodwebs, in light of impacts of watershed land use. Future work incorporating the signatures of basal food resources, and analysis of stomach contents, will help explain whether differences in 13C and 15N values at specific shoreline habitats reflect differences in trophic position of fish at each shoreline type, or in the δ15N signature of water entering from the immediate land-water margin.
The effort to restore the Everglades ecosystem has faced many challenges, including the challenge to quantify the ecological and economic benefits of the program as it is implemented. The SERES project is a DOH-funded effort that synthesizes science information for Everglades’ decision-makers and attempts to address this challenge. The project has developed two aspects of science synthesis which are unique: First, synthesis topics were developed by formally querying decision-makers regarding the scientific questions or themes foremost in manager’s minds. Second, the project is formulating a methodology to link information from physical and ecological research and modeling with ecosystem services that can be valued in monetary terms. One goal of the project is to examine several large-scale scenarios for Everglades restoration, and provide an analysis of the effects of these scenarios on natural resources as well as how these options affect the value of services provided by the Everglades freshwater ecosystem. The project has a core team of 16 physical and natural resources scientists and a project economist, who work on quantifying the changes in key natural resources, linking those resources to people (defining the ecosystem service), and monetizing those changes in Everglades ecosystem services under different restoration scenarios. The SERES project has a freshwater focus that includes hydrology, water quality, soils, vegetative communities, landscape pattern, upper trophic levels and the valued services associated with these different ecosystem components. Despite its freshwater focus, there is a need to consider the downstream implications of different restoration scenarios particularly in their control of estuarine (i.e., Florida Bay) salinity patterns and habitat suitability. We will work collaboratively with the MARES project (an analogous, marine-focused and NOAA-funded synthesis effort) to address these issues at the estuarine ecosystem.

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MISSISSIPPI DELTA RESTORATION IN FOCUS

The deterioration of the Mississippi delta is widely known and most agree that the primary cause is isolation of the river from the delta with hydrologic disruption, enhanced subsidence, and herbivory also important. While the causes of land loss have been debated, there is neither doubt nor debate about how the Louisiana deltaic ecosystem was created. Like many of the world’s largest rivers, the Mississippi River has been shifting its route to the sea for thousands of years. Restoration of the Mississippi delta must include the use of large-scale diversions of Mississippi River water and sediments back into the ecosystem that the River created. Trends in climate change (accelerated sea-level rise, hurricanes, changes in freshwater inflow) will make restoration more difficult. Emerging energy scarcity make restoration more challenging as alternatives are very energy intensive. Restoration is being complicated by a number of controversies including whether 1) inorganic nutrients in river water damage marshes, 2) introduction of river water into estuaries will cause hypoxia and/or harmful algal blooms, 3) the sediment load in the river is too low for effective restoration, 4) diversions will reduce fisheries productivity, and 5) leveeing the River is the primary cause of wetland loss. We believe that only two options are viable for restoration; large-scale diversions which approximate historical diversions and rebuilding marshes with dredged sediments. Climate change and energy scarcity will complicate both of these approaches.

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DAMAGE AND RECOVERY OF BLACK MANGROVE (AVICENNIA GERMINANS) FROM THE JANUARY 2010 FREEZE ON THE LOUISIANA COAST

During January 2010, a hard freeze inflicted widespread damage to black mangroves on the Louisiana coast. Temperature sensors were deployed on 06 January 2010 within the canopy of two black mangrove stands (Fourchon and Bay Junop) prior to the anticipated freeze. Overnight low temperatures on 9, 10, and 11 January 2010 were -3°C to -7°C, resulting in severe leaf burn and whole stem die back of 1.2-m tall black mangrove plants. Return trips were made after the freeze in January 2010, April/May 2010, and a year later in February/March 2011. On 22 January 2010, the effects of the freeze at Fourchon were observed to be widespread but very irregular. The tallest mangrove plants were very green, whereas some adjacent shorter plants had total leaf burn and seemed completely killed, and other plants had live and dead leaves. By May 2010, most of the burned leaves had fallen, some plants were completely denuded, and some of the denuded plants were spraying from the base. The plants which were green in late January were still green in May and seemed to have been unaffected by the freeze. At this time, five individual mangrove plants were identified at each site in each of three categories: green, totally denuded, and denuded with spraying. A total of 30 plants were tagged. Heights of the tallest live stem and dead stem were measured for green plants and denuded plants, respectively. Heights of the tallest dead and live stems were both measured on denuded spraying plants. Four months after the freeze, the spraying plants had regained 35% and 38% of their height at Fourchon and Bay Junop, respectively. One year after the freeze, the sprouted plants were 93% (Fourchon) and 72% (Bay Junop) of their original height. Furthermore, 20% of the totally denuded plants (no sprouts in May 2010) had formed sprouts by one year after the freeze. Even though the 2010 freeze resulted in extensive mangrove dieback, black mangrove continues to spread into salt marsh habitat of Louisiana.

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EL YUCATECO LAGOON, TABASCO, THEIR PHYSICOCHEMICAL AND AUTOREGULATION TENDENCY

The economic services provided by coastal lagoons have affected them in various ways, and few physical, chemical or biological studies have been carried out to determine the degree of alteration. An example is El Yucateco lagoon in Tabasco, Mexico. Agricultural areas border the system, and oil activity infrastructure, laid down in previous years, has now apparently been removed. In order to estimate the autoregulatory capacity of the system, physicochemical characteristics were studied from 2003 to 2009. Seasonal sampling was carried out to quantify the nitrogen and phosphorus nutrients, the mass balance and the Net Metabolism of the Ecosystem (NME), following the LOICZ methods, together with an analysis of Chemical Oxygen Demand and of chlorophyll “a”. Eutrophic conditions, based mainly on total nitrogen and phosphorus, were determined for the period analyzed. A decreasing trend throughout the seven years of the study indicated there is autoregulation, together with an adequate residence time of 50 days. The NME also determined and heterotrophic condition with a tendency to denitrification.

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CHANGES IN SIZE AND ABUNDANCE OF WHITE SHRIMP IN LOUISIANA ESTUARIES FOLLOWING THE DEEPWATER HORIZON OIL SPILL

The Deepwater Horizon oil spill affected offshore areas and estuaries. The timing of the life cycle of white shrimp (Litopenaeus setiferus) may have brought this species in direct contact with spilled crude oil or its contaminants both offshore and inshore. Crude oil contains polycyclic aromatic hydrocarbons, which can, among other effects, reduce growth and affect development in crustaceans. In order to investigate these effects, white shrimp have been collected in Barataria Bay, Caminada Bay and Vermilion Bay since June 2010. Historic data collected at the same sites since 1986 allowed for comparison with variation in abundance and size before the spill. Unexpectedly, our results from year one of the study (June-October 2010) revealed that normalized abundance was higher, and mean size of shrimp was larger in oil-impacted sites. These results could be caused by at least two processes. The shift from large to small shrimp, that usually occurs when large adults leave the estuary and small juveniles enter the estuary, was significantly smaller in oil-impacted sites. This suggests a disruption of the life cycle of white shrimp. Another explanation of the observed higher abundance of large adults is reduced fishing pressure as a result of the fishing closures during the spill. Our results from year two of this study can further help determine the contribution of these two processes to the observed changes.

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MODELLING LATERAL DISTRIBUTION OF FLOW AND BEDLOAD SEDIMENT TRANSPORT IN A TIDAL INLET

A new semi-analytical model is used to calculate tidal and residual velocities in the inlet of a tidal inlet. Currents were compared with observations in Ponce de Leon inlet (east coast of Florida). It is possible to calculate the lateral distribution of flow and bedload sediment transport in a tidal inlet. New aspects of the model are the formulation of a partial slip condition at the bed, a density gradients and a bedlam sediment transport module. Modelled tidal and residual velocities and sedimentation rates were compared with observations and modelled results. The results of the model are consistent with observations and modelled results. The model is a useful tool for studying the lateral distribution of flow and bedload sediment transport in a tidal inlet.
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DEVELOPMENT OF A TOOL TO ESTIMATE BASELINE MACROALGAL BIOMASS AND PERCENT COVER FOR NARRAGANSETT BAY WITH DIGITAL IMAGERY USING A MODIFIED IMAGEJ OPEN SOURCE ANALYTICAL PROGRAM

The Narragansett Bay Estuary Program is developing a biomass and percent cover estimate of drift macroalgae for Narragansett Bay, RI (U.S.) from digital imagery (2007-2011). This data will provide a baseline that can be compared with future conditions after a projected 50% nutrient reduction at all major WWTFs through required tertiary treatment (2014). We have been taking summer monthly aerial digital photography and mapping 5 density classes for drift macroalgae along the western shoreline of Narragansett Bay. Previous efforts using visual estimates of percent cover from digital imagery has proved difficult for distinguishing the “break point” region between density categories due to human inability to visually distinguish small differences in cover. We have developed a java-based add-on to the open source ImageJ program to provide a more objective approach to calculating % cover from digital images. This image processing tool uses a contrast threshold tool to develop a mask that highlights areas with macroalgae, and an HSV threshold control slider that provides a quality control check on the analysis. The tool provides users with little digital analyses experience the ability to identify percentage seaweed cover or other contrasting features in any digital imagery. Such a tool could be used for many purposes, including percentage estimate of oil-impacted shoreline. The tool does not negate the need for ground truthing to identify dominant features such as identification of dominant drift green (Chlorophycophyta) and red (Rhodophycophyta) species and to collect density estimates using 0.1 m² quadrats.

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DOES HERBIVORE PRESSURE AND DIVERSITY VARY ACROSS NORTHERN GULF OF MEXICO SALT MARSHES?

Herbivore-plant interactions have been shown to play central roles in determining the structure of salt marsh communities, and it has been shown that there is a latitudinal gradient with increased herbivory and plant defense in lower latitude marshes. However, relatively little is known about how marsh herbivory varies within a single geographic region. Interestingly, it has been observed that along the northern Gulf coast, marshes in Mississippi are heavily impacted by insect herbivores, while similar sites in Florida remain relatively untouched. To address these observed differences and to examine potential reasons for differences, we have quantified the extent of herbivory at three salt marsh sites in the Grand Bay National Estuarine Research Reserve, Jackson Co., Mississippi and one salt marsh site at Big Lagoon State Park in Escambia Co., Florida. We will present results comparing differences in abundance and diversity of insect herbivores, plant densities, and intensity of herbivory across our study sites. Results of our research will provide a better understanding of factors controlling spatial variation in herbivory within a latitude and will contribute to data important to the development of coastal marsh modeling efforts investigating functioning of salt marsh food webs.

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CHRONIC COASTAL NUTRIENT ENRICHMENT CAUSES SALTMARSH LOSS BY VEGETATED CREEK-BANK FAILURE

Saltmarshes are critical components of the coastal landscape, protecting coastal cities from storms, removing nutrients, and providing critical habitat to fish and wildlife. We provide experimental evidence that the high nutrient levels typical of eutrophic coastal areas exceed the adaptive capacity of marshes, resulting in changes to keystone plants and microbial processes causing creek bank-edge collapse and marsh loss. In a landscape-scale experiment (TIDE), for 8 years we increased the nutrient concentration in the twice-daily tidal water that flood the marsh to levels corresponding to moderately to highly eutrophic coastal waters (nitrate 70 - 100 μM; phosphate 5 μM) in triplicate saltmarsh creeks/heads (primary creek and ca. 30,000 m² of marsh), Plum Island Sound, MA. In less than a decade of experimental nutrient enrichment, saltmarsh geomorphology changed with loss of S. alterniflora marsh along creeks and widening of creeks as banks collapsed. Deep fissures developed at the transition from the low marsh to the high marsh platform and within 1 to 2 meters landward of the transition cracks appeared in the high marsh turf. The number and length of cracks, volume peat sloughed into the channel and extent of mud creek bank increased by 150 to 300% in the nutrient enriched cracks. Alterations in plant allocation (3-16% taller plants with 16% higher specific leaf weight; 38% lower belowground biomass) and increased microbial processing in the enriched systems drove these changes. Overall, despite very high nutrient enrichment in the flooding water our relatively low level of nutrient loading (compared to loading rates in previous dry fertilizer plots) may have exceeded the N processing capacity of the salt marsh ecosystem. At the landscape scale, vegetated creek banks were transformed into mud flats, reducing the capacity of the coastal landscape to remove N and provide other ecosystem functions.
TAYLOR SLOUGH: AN EXAMPLE THAT OPERATIONS AND FLOW CAN EFFECT CHANGES IN THE EVERGLADES AND FLORIDA BAY

Negative ecological changes observed in Everglades and Florida Bay (Bay) in the late 1980s and early 1990s have culminated in the Comprehensive Everglades Restoration Plan. Operational freshwater flow control had reduced stored freshwater volume within the system changing hydroperiods and hydropatterns in marshes and resulting in saltier freshwater transition zone to migrate landward. The changes believed to have contributed to widespread seagrass collapse in the Bay in 1978, wading bird nesting collapse in Everglades National Park, and other negative habitat and species related changes. Freshwater inflow into Taylor Slough was modified in 1993 through canal and channel management; positive differences in the marsh systems and salinity stabilization in the Bay were demonstrated. Salinity data collected since 1955 clearly showed that Bay salinity is most strongly correlated with precipitation and evapotranspiration, but benefited from increased freshwater flow with hypersalinity event reduction. After 2005, drought years mixed with years of high hurricane activity demonstrated operations difficulties in the system without a clear water storage plan. Because flows have not consistently changed since the 1987 seagrass collapse, current patterns in seagrass regrowth indicates that potential exists for future collapse events which occurred after 2005. Higher freshwater flows in the transition zone showed freshwater and brackish water plant assemblage expansion in 1995 until 2005 reporting disappearing after 2005. Increased freshwater flow in mangrove estuaries is higher in smaller-bodied freshwater than abundance and biomass, and thus some forage fish community recovery for piscivorous fishes and wading birds. Current attempts to model flow amount needed to achieve salinity and seagrass community targets in the Bay indicate that two to three times current average flow is required to meet these targets, which is consistent with paleo-based evaluations.

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SALINITY BARRIER REMOVAL FEASIBILITY IN TAMPA BAY TIDAL TRIBUTARIES

Modification of dams, salinity barriers, and other control structures has been a viable restoration option throughout the country. In Tampa Bay, there are more than 100 named and unnamed tidal tributaries. Many of these systems have some active or remnant salinity barrier or hydrologic obstruction within their tidal extent. In addition, some degree of alteration to the creek channel or shoreline is present in most tidally-influenced systems in Tampa Bay. Several tributaries and tidally-influenced canyons that drain to Old Tampa Bay are prime candidates for direct habitat restoration/removal of salinity barrier structures. It is proposed that removal or alteration of structures will provide a number of abiotic and biotic improvements, from reducing flashiness of the system in relation to nutrient discharges, to providing optimum conditions for estuarine-dependent fisheries. GPI Southeast, Inc. (GPI-SE), with co-partners the Tampa Bay Estuary Program (TBEP), and the Southwest Florida Water Management District (SWFWMD), are performing a study to examine the feasibility of removing salinity barriers on tidal tributaries to restore natural salinity and hydrologic regimes, and reduce flashiness. The objectives of the overall study are to inventory the location and extent of salinity barrier structures within Tampa Bay tidal tributaries, determine the feasibility of salinity barrier removal, determine a high priority restoration opportunity within an Old Tampa Bay tidal tributary, and develop site plans for restoration site. As part of the overall study, a separate pilot project will be conducted to collect post-modification data at a salinity control structure. Monitoring will include on-the-ground changes to vegetation, fish community structure, elevation, bathymetry, and water quality. Results from this pilot monitoring study will be applied to the overall study and used as a parameter for selecting restoration opportunities at other tidal tributary sites.

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FIELD ASSESSMENT AND SIMULATION OF SHADING FROM ALTERNATIVE DOCK CONSTRUCTION MATERIALS

Coastal population growth results in an increase in the number of docks built out over the marsh. Our prior research showed that dock shading negatively affects the dominant marsh grass, Spartina alterniflora, and led to changes in dock permitting in Georgia. Alternative dock construction materials and methods have been proposed as a way to reduce the impact of marsh shading. This study assessed shading produced by alternative docks, along with physical and biological changes associated with these structures and makes recommendations for further permitting changes. Four alternative docks were constructed to assess shading impacts: traditional wooden planking, plastic Thruflow™ decking, fiberglass Fibergate™ decking and a Dockrider Systems SunDock™. The simulated docks investigated the effects of orientation and height on shading using light sensors above and below the docks to measure photosynthetic active radiation (PAR) during quarterly seasonal assessments. During spring and summer, when the sun’s angle is high, shading from an N-S oriented, traditional dock produces a 44% loss of daily PAR, whereas an E-W oriented dock exhibits an 83% loss. Dock height is directly correlated with shade durations beneath docks. For a N-S oriented, traditional dock during the summer, daily PAR loss ranged from 52% to 30% to 2.4 m. Effectiveness of alternative dock materials was related to season; during fall and winter, alternative materials exhibited no additional PAR transmission when compared to traditional dock, during Spring transmission was low and variable (0-9%), and during Summer transmission was approximately 20% greater. The Dockrider Systems SunDock™ always transmitted the greatest amount of PAR. Physical and biological parameters were quantified at three sites with docks constructed using the materials and methods described in this study. Stem density decreased ~50% and biomass decreased between 15 and 63% beneath docks with alternative decking.

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THE GEOLOGICAL RECORD OF A HURRICANE IMPACT AND STORM SURGE EBB WITHIN A BARRIER ISLAND LAGOON: THE IMPACT OF EAST GALVESTON BAY BY HURRICANE IKE (SEPTEMBER 13, 2008)

Hurricane Ike made landfall on the Bolivar Peninsula barrier spit on September 13, 2008, as a Saffir-Simpson Hurricane Category 2 storm, producing a storm surge in excess of 5 meters across the barrier spit and into the East Galveston Bay. Geophysical and core surveys began less than 1 year after storm, initially investigating the impact of the storm on the oyster reef communities in the bay, subsequent surveys focused on sediment transport and deposition within the bay as a whole. Results show that the storm deposit is generally 1 to 2 m thick and contains two distinct layers, each up to 1 m thick, with a basal sand dominated layer and an upper mud dominated layer. The basal sand layer extends from the southern shoreline of the bay as a lobe thining across the bay towards the northern mainland shoreline. The mud deposit extends as a lobe deposit from the mainland southward across the bay towards Bolivar Peninsula. 8C13 analyses of organic matter within the sediment reveal basal layer is dominantly marine derived organic matter and the upper layer is dominantly terrestrially derived. Based on these results, it appears that during the pre-frontal portion of the storm, the storm surge transported mud and sand from the Gulf of Mexico (marine) and sand from Bolivar Peninsula across Bolivar Peninsula into East Galveston Bay. As the storm surge continued to rise, it inundated over 900 km2 of mainland across the northern shore of East

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The impact of East Galveston Bay by Hurricane Ike (September 13, 2008)
Galveston Bay, mainly consisting of extensive mud dominated freshwater marshes. This area was pounded by waves for at least 12 hours prior to the passage of the eye. After the eye of the storm passed (post frontal phase), the rapidly retreating storm surge ebbed delivered muddy sediment into the bay derived primarily from the erosion of the mainland.

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HIGH-END UNDERGRADUATE RESEARCH EXPERIENCES 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 ~1700 undergraduates, with ~1100 undergraduates and ~125 graduate students seeking degrees in marine biology, marine science, oceanography, marine resource management and marine engineering. With 25 active research labs, involving undergraduates in field and lab-based research has been a significant and necessary part of our history. We define undergraduate research as an activity where the student develops and tests a scientific hypothesis or hypotheses through the generation, analyses and assimilation of new or existing data via a research tool, field sampling, laboratory analyses, or computer modeling, under the guidance of a qualified mentor with the ultimate goal of making findings available to the wider scientific community through presentation and publication of research findings. We recently developed a formalized undergraduate research program, components of which includes an Honors program, an NSF Research Experience for Undergraduates (REU) summer internship in marine science and marine biology, field and lab-based research classes, paid research internships, and an annual research symposium. The TAMUG Honors program includes an Honors Thesis conducted in a research lab during their Junior and Senior years. Research classes include capstone engineering projects and hypothesis driven, semester-long research projects in the research symposium and formally written research papers. Participation in these programs currently varies widely by department, with some departments and programs having 60-100% participation in at least one of our programs prior to graduation. Within our Marine Sciences Department, our goal has been to provide all undergraduates who have a B average or higher with a high-end undergraduate research experience.

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PLANNING AND EVALUATING WORKSHOPS FOR COASTAL RESOURCE MANAGERS

This presentation addresses planning, implementing, and evaluating a workshop for coastal resource managers as part of a five-year NOAA-sponsored project: Ecological Effects of Sea Level Rise in the Northern Gulf of Mexico (EESLR-NGOM). The project involves detailed assessment and predictions on sea level rise (SLR) effects on infrastructure and coastal wetland habitats along the central northern Gulf coast. Better understanding these effects will help determine viability of future management actions relative to predicted conditions. Crucial is translating the scientific findings into products that can be readily used by managers and applied to similar locations. The workshop will help align research products with operational needs. The workshop objectives were to: overview the EESLR-NGOM project and products; learn about noted/expected ecological changes and concerns; solicit input on products’ content/format; identify gaps in products, user groups, and target audiences; and connect with ongoing SLR research and extension. Sixteen coastal resource managers who work within/are familiar with the region were invited to participate. The workshop structure included the project overview; scientific presentations with questions/answer time; facilitated panel discussions on ecological changes noted, level of concern about SLR issues, reactions to the presentations, and identification of product user groups; a scientific planning meeting, and a focus group. The focus group was incorporated to better understand managers’ SLR-related behaviors and informational needs, solicit input on product development, and gather outreach recommendations. Evaluation involved constructing, administering, and analyzing a survey of participants at the workshop conclusion to examine instrument user satisfaction with the workshop’s content, format, networking opportunities, and usefulness and gathered suggestions for the future. Evaluation results will be included in this presentation.

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THE ROLE OF ECTOPARASITES IN CARIBBEAN CORAL-REEF FOOD WEBS

In coral-reef ecosystems, ectoparasites directly impact food webs through their role in cleaning symbioses. However, they are typically overlooked in the development of food-web models. Gnathiid isopod larvae are common ectoparasites of reef fishes and are important in the diet of cleaner organisms. They have benthic life history stages, can be transferred between habitats via hosts, and can be eaten by other predators during free-swimming stages. By comparison, cymothoid isopods of the genus Anilocra attach to hosts as juveniles and remain attached to the host. By including these parasites in coral reef food-web models via stable isotope analysis, we gain a better understanding of their role in transfer of energy through coral reef ecosystems. Caged damselfish, grunts, snapper, soldierfish, and red hind were deployed and then retrieved during peak gnathiid infestation (dawn and midnight) on St. John, USVI and Guana Island, BV1. Gnathuids collected from infested fish were either preserved immediately or allowed to metamorphose. In addition, host-attached parasitic Anilocra spp. isopods were collected from free-living individuals of six fish species. In order to evaluate how fish-derived carbon (energy) is transferred from gnathuids to parasite consumers, we fed gnathuids from specific host fish to captive Pederson shrimp (Anilocromes pedersoni) for 1 month. Fish tissue (heart, gill, muscle, scales, blood), gnathuids, Anilocra isopods, and shrimp were analyzed for stable carbon and nitrogen isotopes. Isopods had δ13C and δ15N values similar to their host, comparable to results from other host-parasite studies. Gnathiid-fed Pedersen shrimp also had δ13C values consistent with their food source and enriched in δ15N as predicted due to trophic fractionation. These results indicate that stable isotopes can be an effective tool in deciphering energetic feeding relationships and the role of parasites in carbon transfer among coral-reef ecosystems.

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RESPONSES OF ZOOPLANKTON ASSEMBLAGES TO VARIABLE FRESHWATER INFLOW IN THE CALOOSAHATCHEE RIVER AND ESTUARY, FLORIDA

Freshwater inflow to the Caloosahatchee River and Estuary in Southwest Florida is highly variable and modifies estuarine productivity by altering physical conditions shaping associated zooplankton assemblages. To establish linkages between physical conditions and biological assemblages, monthly nighttime zooplankton surveys were conducted over 47 km of the river and estuary during a two-year period. Inflow varied from 0 to 136.0 m3 s-1 in the wet season and 0 to 41.1 m3 s-1 in the dry season. Salinity varied seasonally with mean salinity measured at 3.26% upstream and 32.30% downstream, as the system switched from being well-mixed during wet months to being a salt- wedge estuary in the dry season. These physical changes were reflected by responses in the zooplankton assemblage: negative regression slopes between freshwater inflow and centers of abundance demonstrated drastic downstream displacement during wet months for estuarine assemblages; abundance and biodiversity of estuarine copepods as well as all Anchous sp. developmental stages were higher in the dry season and were positively correlated (p<0.05) to one another. In contrast, increased freshwater inflow altered the copepod community to freshwater prevalent species that were only significantly positively correlated with adult A. mitchelli. These seasonal and spatial differences in zooplankton assemblages can be used to assess ecosystem change, predict future environmental impact based on changes in precipitation and water use, and develop targets for restoration and enhancement.

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ATMOSPHERIC DEPOSITION FIELD AND SOURCE CONTRIBUTION FROM CMAQ FOR THE CHESAPEAKE BAY TMDL PROCESS

Background information on the Community Multiscale Air Quality (CMAQ) model and the processes it needs to model to calculation atmospheric nitrogen deposition will be presented. Example airsheds matched to watersheds will be shown to illustrate how large airsheds can be. The 12 km grid relative to the Bay basins and watershed segments will be shown. Fields of oxidized-nitrogen deposition (from nitrogen oxide emissions, NOx) and reduced-nitrogen deposition (from ammonia emissions, NH3) will be illustrated. The need for attribution matrices for both oxidized-nitrogen and reduced-nitrogen will be noted as well as the desire...
to develop them by state (political jurisdiction) and major emitting sector. The special model version of CMAQ to calculate the source attribution fields, using the Direct Decoupled Method, will be briefly described. Source attribution maps will be presented to show the overall results and illustrate them for example Bay States. Finally, development and illustration of a source attribution matrix for the TMDL process, to allow air-water trading, will be presented.

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INNOVATIONS IN ENVIRONMENTAL COMMUNICATION, REPORTING AND GOVERNANCE

The coastal zones of the world provide some of the most acute environmental challenges on the planet. The proliferation of coastal megacities and coastal population pressures impact coastal ecosystems, leading to degradation of coastal ecosystems like salt marshes, mangrove forests, seagrass meadows and coral reefs. Iconic regions like Chesapeake Bay and the Great Barrier Reef are threatened by various human pressures, including accelerated climate change. These challenges promote a search for innovations in environmental communication, reporting and governance. Scientific synthesis needs to evolve better communication to resource managers and policy makers. Innovations in science communication include the development of online conceptual diagram drawing programs, the evolution of design/layout communication products for print and ereader formats, and video seminars and training content. Innovations in environmental reporting include environmental report cards (e.g., Chesapeake Bay, Great Barrier Reef, Southeast Queensland), which have evolved to include citizen science monitoring, management response monitoring, and public health monitoring. Governance innovation is exemplified by regional resource management authorities and by a rigorous evidence-based approach to decision-making (e.g., BayStat). These innovations in environmental communication, reporting and governance will need to be tested and applied more widely across the globe so that scientists can solve, not just study, environmental problems.

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TRACKING AGRICULTURAL POLLUTANT IMPACTS TO THE GREAT BARRIER REEF THROUGH AN ANNUAL REPORT CARD

The Queensland Government and the University of Maryland Center for Environmental Science have developed an annual report card to track metrics relating Great Barrier Reef ecological health and agricultural land management pressures. The report card is a key output of the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program which is implemented over a 400,000 km² land area and a coral reef system stretching 2300 km along Australia’s east coast. Metrics are directly related to performance targets set out in an ambitious policy directive from the Australian and Queensland Governments to protect the Great Barrier Reef from agricultural diffuse source pollution. The Reef Water Quality Protection Plan has a suite of measures that enable agricultural land holders to adopt improved farm practices. Land practice adoption targets include 80% adoption of improved practices for nutrient, chemical and soils for most agricultural enterprises, and 50% adoption of improved pasture and riparian practices by grazing enterprises. The effect of these improvements will be tracked through continued monitoring of catchment land condition, pollutant loading through riverine inputs, and water quality and reef resource condition. Program targets include a 50% reduction in nutrient and pesticide loading by 2013, and a 20% reduction in sediment loading by 2020. Although the Reef remains in moderate condition overall, initial results suggest that improvements to land management practice adoption should continue. The results highlight that there are significant areas of concern that justify the need for accelerated action to improve water quality and build resilience of the Great Barrier Reef. These include five to nine times the natural loads of pollutants; significant loss of some freshwater wetlands; decline of seagrasses in some areas and the exceedance of water quality guidelines for pesticides in marine areas.

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INNOVATIONS IN ENVIRONMENTAL COMMUNICATION, REPORTING AND GOVERNANCE

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SHELLFISH RESTORATION MEETS SOCIO-ECONOMIC RESTORATION ALONG ALABAMA’S COAST

Mobile Bay, Alabama, the fourth largest estuary in the United States, plays an important role in nurturing the finfish, shrimp, crabs and oysters that are vital to Gulf of Mexico communities. It has experienced significant loss of critical coastal habitats (i.e. oyster reefs, seagrass beds) that shelter such species through dredge activities, seawalls, erosion, storm events, and other causes. In 2009, TNC-AL received funding from NOAA, through the American Recovery and Reinvestment Act, to significantly increase restoration efforts with the creation of over 1.5 miles of oyster reef. This effort, and the science behind it, now serves as the foundation to take restoration to a landscape or ecosystem-scale. For example, partnerships in coastal Alabama have kicked off the 100-1000: Restore Coastal Alabama project, which engages community, local agencies and federal partners to build 100 miles of oyster reef and create 1,000 acres of marsh/seagrass. A significant component of landscape scale restoration projects are the socio-economic benefits. This presentation will focus on the job creation, volunteer involvement, and community support associated with restoration. The construction of these projects provides immediate jobs for members of the communities that are suffering from the effects of the economic downturn and oil spill. Additionally, citizens that raised their hands to help clean-up the oil spill were sidelined because of the harmful nature of the oil. A recent volunteer restoration event included 600 volunteers, where 25,000 bags of oyster shell were deployed to create over 400 meters of living shoreline, which fostered a community investment in the recovery of the Gulf. Communication of the results of the restoration project to government agencies, NGOs, scientists, fishing industries and the public is also an important component and includes community meetings, media outlets, scientific conferences, and education programs that target k-12 students.

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USE OF THE USEPA ESTUARY NITROGEN MODEL TO ESTIMATE CONCENTRATIONS OF TOTAL NITROGEN IN ESTUARIES USING LOADS CALCULATED BY WATERSHED MODELS AND MONITORING DATA

We use USEPA’s Estuary Nitrogen Model (ENM) to calculate annual average concentrations of total nitrogen (TN) in ten estuaries or sub-estuaries along the Atlantic coast from New Hampshire to Florida. These include a variety of systems, ranging from strongly-flushed bays to weakly-flushed, microtidal lagoons. The ENM is a box model that calculates annual spatially-averaged concentrations in an estuary using the estuary flushing time and the sum of TN loadings from the watershed (modeled or measured), atmosphere, discharges directly to the estuary, and inputs across the seaward boundary. Input from the seaward boundary is estimated from nitrogen concentration and salinity at this boundary and mean salinity in the estuary. The model assumes first-order kinetics for loss of nitrogen to denitrification and long-term burial in sediment within the estuary. Surface-water loads of TN were calculated using the USGS SPARRow model, or (for most Florida estuaries) the St. Johns River Water Management District’s Pollutant Load Screening Model (PLSM). Comparison of calculated and measured in-estuary TN concentrations shows good agreement. We also demonstrate use of the ENM to estimate throughput to the seaward boundary of TN from individual sources, the relative contributions of loading from individual sources (the watershed, direct discharges to the estuary, and input across the seaward boundary) to the TN content of the estuary, and to determine the sensitivity of in-estuary concentrations to changes in loading from the watershed. These results demonstrate the utility of linking watershed models with environmental models to assess the nitrogen content of estuaries and their sensitivity to changes in loading. The ENM has been used by state and regional agencies to assess TN concentrations and sources in estuaries.
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ANALYSES OF ARCHAEOAL COMMUNITIES IN GULF OF MEXICO DEAD ZONE SEDIMENTS

Sediments may contribute significantly to Louisiana continental shelf “dead zone” hypoxia but limited information hinders comparison of sediment biogeochemistry between normoxic and hypoxic seasons. Dead zone sediment cores collected during hypoxia (September 2006) had higher levels of NH4+, Fe2+ and dissolved inorganic carbon in porewater, and reduced solid iron, than cores collected in norm-oxic conditions (April 2006). These results suggest reduced end products of microbial respiration accumulated as oxygen diminished in the overlying water. In sediments, different microorganisms compete for the same electron donors and acceptors and against abiotic reactions. Analyses of microbial communities might help to differentiate processes taking place in the sediments. Archaea have been shown to dominate ammonium-oxidizer communities in marine systems. Therefore, pyrosequencing of 16S rRNA genes using Archaea-specific primers was undertaken to investigate archaeal community composition in the April and September 2006 sediment cores. Crenarchaeote sequences accounted for over half of the 260,000 sequences obtained. The most abundant cluster of genus-level (97% similarity) sequences contained that of an uncultured, Desulfurococcaceae-related archaeon. Sequences within the cluster accounted for 11% of all those obtained. They were most abundant in the deepest sediment core fractions (6 to 10 cm) collected during hypoxic conditions in September. The next three most abundant clusters included the ammonium-oxidizing archaeon, Nitrospumilus and accounted for 15% of the total sequences. Nitrospumilus clusters were most abundant in the upper 6 cm of sediment and were significantly higher in cores collected under norm-oxic conditions. These results reveal changes in the community structure of Archaea in the upper sediments, including abundance of Nitrospumilus spp., which may be associated with the availability of oxygen needed for ammonium oxidation.

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SERVICE-LEARNING IN UNDERGRADUATE AND GRADUATE MARINE BIOLOGY COURSES: STRATEGIES FOR ENHANCING BOTH LEARNING AND COMMUNITY ENGAGEMENT

Service-learning is a pedagogy that addresses course objectives by taking students out of their classrooms and into the community to learn about both course content and civic responsibility. It has been practiced in humanities courses since the early 1990s and is now being taught in marine biology courses at universities. In two marine biology courses at the University of Central Florida, service-learning was employed to promote students’ science communication skills. Here, we present two service-learning projects—one that includes science-service learning as one of many elements in the course (11% of final grade), and another in which service-learning accounted for over 50% of the final grade. In a 25-person, upper-division, undergraduate Marine Biology class, students worked in teams to produce short movies on current marine topics, such as harmful algal blooms and ocean acidification. Fifty high school students from a local, urban school came for a Saturday morning film festival during which they learned and judged content, participated in oyster restoration, and received small group campus tours. Class time dedicated to this project was 3 weeks. An alternative strategy was used in a graduate-level Marine Conservation Biology class where the 15 students, working in pairs, were engaged in a semester-long service-learning project in collaboration with a local educator (pre-K through high school; UCF students chose age range). UCF students and educators agreed on a topic and then the UCF students prepared and presented information to the K-12 classes. Each team produced a PowerPoint presentation, a hands-on activity and a visual product (e.g., poster, video, flash quizzes, etc.). All of which the K-12 educator could use and share with colleagues. Evaluations showed that the UCF students in both models found this to be a valuable method for improving their science communication skills and most liked engaging with the community. Assessments demonstrated increased student learning.

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SIZE MATTERS: THE CONTRIBUTION OF MEGA-INFAUNA TO THE FOOD WEB AND ECOSYSTEM SERVICES OF AN OREGON ESTUARY

Large-bodied invertebrates (bivalves, polychaetes, burrowing shrimps) are common to infaunal communities of Pacific estuaries, but their contribution to estuarine ecological function, and ecosystem services is poorly understood because they are difficult to sample and quantify. In a study of Yaquina estuary (OR) food webs, particular effort was made to quantify intertidal and subtidal mega-infauna using suction-excavated 40-cm diameter corers in addition to conventional sampling of macro-infauna. Additionally, the abundance and biomass of all floral and other faunal guilds (except microbial and mammalian guilds) were directly quantified or estimated from published studies. C and N stable isotopes were measured for abundant species, and inverse analysis was used to generate models of C flow within food webs of the lower and upper reaches of the estuary. Benthic invertebrates dominated the biomass and respiration within faunal guilds in both reaches, whereas biomass and respiration of birds and fish were two orders of magnitude smaller. Mega-infauna, particularly intertidal burrowing shrimps and bivalves, constituted most of the benthic invertebrate biomass, respiration, and secondary production in both reaches, although they were only a small fraction of the infaunal abundance. Mega-infauna were dominant consumers of phytoplankton, major contributors of C to sediment organic matter, and facilitated C and N flux between sediments and the water column. However, nutrient and trace metal uptake are relatively more important as prey for fish, crabs and birds. Mega-infauna contributed directly to estuarine ecosystem services as fishery species (clams, burrowing shrimp) and indirectly by supporting fish, crab and bird populations, by accelerating C and N cycling, and by improving water clarity through filter feeding. Underestimation of mega-infaunal abundance resulted in substantial underestimation of C flow in the food webs and of production of ecosystem services.

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THE ABUNDANCE, DISTRIBUTION AND BIOGEOCHEMISTRY OF MARINE PLANTS AND ALGAE IN BISCAYNE BAY, FLORIDA

Biscayne Bay is a semi-enclosed estuary on the southeastern edge of the state of Florida. Biscayne Bay is subject to a variety of anthropogenic uses which collectively place the delicate benthic ecosystem at risk. This ecosystem provides numerous goods and services to the local community including coastline protection, water quality enhancement, nursery beds for commercial fisheries, and feeding beds for diurnal reef fish species. Long-term sampling programs and other studies in the bay have demonstrated that there is a spatial pattern to nutrient distribution in the water column, with consequences for seagrass distribution and community structure. We embarked on a large scale sampling effort to investigate the biogeochemical patterns in the benthos, as well as the population distribution and structure of the primary producers that inhabit Biscayne Bay. We report that population structure of benthic communities are largely driven by changes in benthic nitrogen within the Bay, especially near developed shorelines. Halodule wrightii is dominant near the coastline, and Thalassia testudinum becomes more prevalent as one moves closer to the reef tract. Phosphorus concentrations also show spatial variation with higher concentrations nearer the shoreline. Benthic concentrations of nitrogen and phosphorus were also reflected in the foliage of the seagrass tissue, indicating that these nutrients were determinants of the spatial coverage of seagrasses within the bay. Macroalgal species distribution correlated to nutrient concentrations in the nearshore environment and was dominated by varying distributions of Halimeda spp., Batophora oerstedii and Chorda hornemani. Understanding the distribution and influences of primary producer distribution within the bay can aid in its long term protection.

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SEASONAL PRODUCTION AND BIOMASS OF THE SEAGRASS SYRINGIDIUM FILIFORME KÄTZING IN A SUBTROPICAL TEXAS LAGOON

The seasonal pattern of biomass and production for the seagrass Syringodium filiforme (Kütz.) is presented for the Lower Laguna Madre of Texas at two sites from January 1996 to August 1997. Site C was more protected with resultant clearer water while Site 103 was more turbid due to greater wind exposure and proximity to a dredged shipping channel. Annual subsurface quanta at Site C was 10% greater than Site 103 (7000 versus 6300 mol photons m-2 yr-1). Mean surface irradiance was 55% and 51% for Site C and Site 103, respectively, well above the minimum light requirement needed to maintain Syringodium. Biomass and primary production was significantly higher at Site C than at Site 103 due to reproductive effort but leaves were longer at Site 103 suggesting that light was limiting at...
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Site 103. In contrast, rhizome elongation rates were higher at Site 103 which could be related to lower pore water nutrient supply.

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ROLE OF THE UNITED STATES DEPARTMENT OF INTERIOR IN REGIONAL OCEAN GOVERNANCE UNDER THE NATIONAL OCEAN POLICY INITIATIVE

On July 19, 2010, President Obama signed an Executive Order (E.O. 13547) establishing the nation’s first integrated national policy for the Stewardship of the Ocean, Coasts, and Great Lakes. The National Ocean Policy (NOP) also provides a framework for regional ocean governance through the Coastal and Marine Spatial Planning (CMSP) priority initiative. Guided by such principles as the precautionary approach and Ecosystem Based Management (EBM), and informed by the best available information, CMSP is a comprehensive spatial planning process for analyzing current and anticipated ocean uses. Coastal and Marine Spatial plans will be developed at the regional level based on input from federal, state, local and tribal stakeholders. It is anticipated that regional CMSP plans will enhance regulatory certainty, minimize conflicts among competing resource users, and achieve optimal site selection for such space-intensive resources as offshore wind power. The United States Department of the Interior (DOI) regulates ocean energy and mineral resources on approximately 1.8 billion ocean acres. Given our ocean role, the agency is fully engaged in the National Ocean Policy and CMSP initiative. The agency is actively supporting the existing regional ocean councils such as the Mid-Atlantic Regional Council on the Ocean (MARCO) to kick-start the coastal and marine spatial planning process at the regional level. DOI is also engaged in the preparation of the National CMSP workshop, and it will provide support for regional workshops where regional plans will be prepared. This presentation will discuss the evolution of a new regional ocean governance structure under the National Ocean Policy. It will also discuss DOI’s engagement in the National Ocean Policy, and report on CMSP implementation at the national and regional levels.

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THE IMPORTANCE OF ALLOCHTHONOUS SUBSIDIES TO AN ESTUARINE FOOD WEB ALONG A SALINITY GRADIENT

Estuarine food webs function within a heterogeneous mosaic and are supported by a mix of primary producers from both local and distant sources. Processes governing the exchange and consumption of organic matter (OM), however, are poorly understood. To study the contribution of autochthonous and allochthonous OM sources to primary consumers in the Minho River estuary (N-Portugal, Europe), we characterized the carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) stable isotope ratios of primary consumers (zooplankton and the invasive clam Corbicula fluminea) and their potential OM sources, as well as the concentration and stable isotope ratios of dissolved inorganic carbon (DIC) and particulate OM (POM) along the estuarine salinity gradient. The $\delta^{13}C_{POM}$ values were lowest in the tidal freshwater (TFW) portion and higher toward the river mouth, following the expected conservative mixing. In the TFW portion, particulate organic carbon (POC) $\delta^{13}C_{POC}$ values (bottom: -28.5‰ to -25.5‰; surface: -29.3‰ to -26.3‰) and C:N (10) of particulate samples indicated that terrestrial-derived sediments were a large portion of the bulk POM pool. In the polyhaline portion, $\delta^{13}C_{POM}$ values (bottom: -20.5‰ to -18.8‰; surface: -25.5‰ to -23.2‰) indicated that the bulk POM pool was generally derived from phytoplankton. In the brackish estuary, zooplankton $\delta^{13}C$ values were similar to bottom $\delta^{13}C_{POC}$ values, suggesting that marine-derived OM provided a subsidy to the planktonic food web. In contrast, zooplankton $\delta^{13}C$ values in the TFW were similar to surface and bottom $\delta^{13}C_{POM}$ values, suggesting increasing importance of terrestrial-derived OM. Corbicula fluminea presented a similar trend to the zooplankton in the TFW, suggesting that the benthic food web was also subsidized by terrestrial-derived OM. Our stable isotope data suggest that the Minho River estuary has a high degree of connectivity along the estuarine salinity gradient and that both marine and freshwater inputs provide a food web subsidy.

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CHANGING DIMENSIONS OF COMMUNITY WELL-BEING IN THE WAKE OF THE DEEPWATER HORIZON DISASTER

Beginning on April 20, 2010 and continuing for nearly three months, oil gushed from the open Macondo Prospect wellhead beneath the surface of the Gulf of Mexico, becoming the largest marine oil spill in our history. The oil washed ashore in communities from Louisiana to Florida. Though much attention and research have been focused on the environmental damage caused by the disaster, it is also crucial to assess the impact on society. <P> In this project, we will develop a methodological approach for the quantification of community well-being at the county level in order to explore the impacts of the Deepwater Horizon (DWH) disaster on coastal communities in the Gulf of Mexico. We will employ a longitudinal research design to examine changes in dimensions of well-being over a 10 year period of time that includes 2010. Social, economic, general health, safety, employment and similar types of secondary data regularly collected by the US Census Bureau and other federal, state and local agencies will be collected and analyzed. Data on environmental conditions will be used to assess the dynamic relationship between the ecosystem services that people regularly enjoyed prior to the disaster and community well-being. The study will be focused on coastal counties directly impacted by oiled shorelines, as well as a selection of comparison counties. <P> To prepare for and respond to environmental events like the DWH disaster, decision makers, resource managers, and other government officials need information about the social and economic aspects of their communities. By establishing a method for monitoring those changes, this project will fill gaps in information about the status of impacted communities and their recovery from the DWH disaster, as well as other major environmental events in the past decade. Indicator development, measure selection, as well as methodological challenges and solutions will be explored alongside progress to date.

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HURRICANE IMPACTS ON ECOLOGICAL SERVICES AND ECONOMIC VALUES OF COASTAL URBAN FOREST: A CASE STUDY OF PENSACOLA, FLORIDA

As urbanized areas continue to grow and green spaces dwindle, the importance of urban forests increases for both ecologically derived health benefits and for their potential to mitigate climate change. This study examined pre- and post- hurricane conditions of Pensacola’s urban forest and the associated potential economic and ecological impacts the 2004 and 2005 hurricane seasons had on the human benefits derived from the region’s urban forest canopy. Using CITYgreen® for ArcGIS, 33 random sites in southern Escambia County, FL were analyzed using aerial photographs taken pre- and post- hurricane impacts to calculate quantities for total impervious surfaces, total open spaces, total canopy, and associated economic values for air pollution removal, total carbon stored, annual carbon sequestration ability as a result of significant canopy loss. Stormwater retention capacity was reduced after the 2004 and 2005 hurricane seasons. Case studies such as this one illustrate the large benefits that humans receive from the more natural components of their surroundings. Assessments of the large changes in ecosystem functions associated with large natural disturbances may help galvanize efforts to assess changes in ecosystem services and associated benefits for manageable factors such as those associated with tree planting and preservation ordinances, stormwater management through green infrastructure, and community level development planning.

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DRY SEASON INFLOWS TO THE CALOSAHSATCHEE ESTUARY BASED ON THE DISTRIBUTION AND ABUNDANCE OF ZOOPLANKTON

The Calosahatchee River and Estuary, located on the southwest coast of Florida, comprise a system that has been highly altered from its natural state by human intervention and engineering. The river has been straightened, deepened, artificially connected to Lake Okeechobee and three water control structures have been added to provide flood control and prevent salt water intrusion. freshwater inflow to the estuary is highly variable on seasonal time scales. During the wet season, the estuary can turn entirely fresh. During the dry season, flow from the river to the estuary often ceases and salinity can exceed 10 ppt at the crest of the estuary and dam structure (located at Hamilton) dam. The south Florida Water Management District uses a resource based approach to determine the quantity
of water required for environmental purposes. Data from a three year study of zooplankton (including ichthyoplankton) were analyzed to help quantify appropriate flows for the Caloosahatchee. The copepod, Acartia tonsa, comprised the highest proportion of organisms in a 505 micron mesh net. Analysis of variance indicated that the volume weighted mean results for other taxa indicate appropriate dry season flows ranging from 150 - 1500 cfs. These and estuary during this period were associated with flows at S-79 of about 350 cfs. These and for other taxa indicate appropriate dry season flows ranging from 150 - 1500 cfs. Anchoves were most abundant in the estuary during the latter part of the dry season and beginning of the wet season (March-June). A non-linear, lognormal regression indicated that peak densities in the estuary during this period were associated with flows at S-79 of about 350 cfs. These and results for other taxa indicate appropriate dry season flows ranging from 150 - 1500 cfs. Anchoves were most abundant in the estuary during the latter part of the dry season and beginning of the wet season (March-June). A non-linear, lognormal regression indicated that peak densities in the estuary during this period were associated with flows at S-79 of about 350 cfs. These and

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RESILIENCE AND COMMUNITY CHANGE: TRACKING HYPOXIA AND ROCKY REEF COMMUNITY STRUCTURE ON THE OREGON SHELF

The development of shelf hypoxia and/or anoxia is a common feature of many eastern boundary current systems where enhanced rates of export production and cross-shelf transport of oxygen-poor waters serve as key determinants of ecosystem oxygen budgets. A number of studies have recently identified and described the rapid expansion and intensification of hypoxia, including the novel emergence of inner-shelf anoxia in the California Current large marine ecosystem (CCLME). While the onset of hypoxia can perturb coastal food webs and fisheries, our understanding of impacts to the system are limited by availability of baseline ecological information and coupled hydrographic and biological datasets, and the difficulty of quantifying biological responses to episodic events at depth. Through analyses of video footage from archived and new Remotely Operated Vehicle surveys, we tracked changes in both oxygen and community structure of benthic fishes and invertebrates for 11 years at a rocky reef on Oregon’s inner-shelf (ca. 50m depth). Preliminary analyses reveal both acute impacts on fish community structure and their potential for recovery following seasonal hypoxia events. Characterization of invertebrate community structure prior to and following the onset of anoxia also revealed patterns of taxa-specific sensitivity to oxygen deficit stress in-situ, and rates of recolonization and population recovery. These findings provide new insights into the resilience of rocky reef communities as well as trajectories of community reorganization in response to oceanographically induced oxygen changes.

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MOSQUITO IMPOUNDMENT RESTORATION IN NORTHERN MOSQUITO LAGOON

Hydrology is a critical factor in wetland diversity and function and human alterations of hydrology often negatively impact wetlands beyond the intended management goals. Since the 1950s, approximately 75% of coastal wetlands associated with the Indian River Lagoon were impounded for mosquito management. Impoundments were created by building dikes around marshes, changing the natural hydrology to control interior water levels during mosquito breeding. Wetland habitat decreased because elevated dikes were too dry to support wetland species and interior marsh communities were altered due to limited tidal flow and changes in salinity. Dikes were invaded by terrestrial native and non-native plants, restricting wetland plants and animals to exterior edges of dikes. Initial restoration efforts focused on reconnecting interior marshes by installing culverts through dikes. Full restoration began in the late 1990s by mechanically leveling dikes to wetland elevations, followed by natural regeneration of plants from neighboring sources. Plant and fiddler crab monitoring began in 2005 and included three restored impoundments in different stages of recovery and two reference marshes. Two additional impoundments were added in 2007 and fish, mobile invertebrates, and birds were added to the monitoring protocol. Post-restoration monitoring identified important factors in habitat recovery and provided management recommendations, including: 1) target elevations for promoting natural hydrological properties, 2) effectiveness of natural regeneration following dike leveling, 3) benefits of leaving shoreline wetland vegetation intact to enhance the rate of plant recovery on leveled portion of dike, and 4) importance of abiotic conditions to prevent non-native plant recruitment. Lessons learned were used to guide impoundment restoration beginning in 2009 and monitoring data are now regularly evaluated to set restoration objectives and targets for success.

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NON-NATIVE SPECIES ON FLORIDA’S EAST COAST: SHOULD WE BE WORRIED?

Invasion by non-native species, organisms transported outside their natural range, is a major threat to natural land and water bodies worldwide. Estuaries are particularly vulnerable because of high levels of human activity, increasing chances of accidental or intentional release of non-native organisms. Only a small percentage of globally transported plants, animals and microbes become established in their introduced range; however, when organisms invade natural communities, it can cause widespread changes in native habitats and disrupt ecosystem services and economic activities. The Indian River Lagoon (IRL) system, an estuary located at the temperate-sub-tropical boundary on the east coast of Florida, is one of the most diverse estuaries in the United States. Variety in upland and submerged habitats combined with the mild climate of the IRL creates favorable conditions for invasion by non-natives, threatening both native species and economic benefits to local communities. Our research in the IRL has documented non-native plant and invertebrate species invading ecologically and economically important habitats. Three plant species, Schinus terebinthifolius (Brazilian pepper), Panicum repens (torpedo grass), and Lantana camara (shrub verbena), are identified as severe threats to natural habitats and have negative impacts on native plants. Furthermore, newly found fouling species, Mytilia charruana (charru mussel), Perna viridis (Asian green mussel), and Megabalanus coccopoma (Pink tin悄on barnacle) have been recorded on oyster reefs, a critical habitat supporting local fisheries. These non-native invertebrates could potentially displace the native structure, forming oysters and associated fauna. On-going research and monitoring is being used to identify impacts in natural habitats, test physiological tolerances, predict future invasions, and evaluate responses to management actions.

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VARIABLE PHYTOPLANKTON COMMUNITY COMPOSITION IN RESPONSE TO FRESHWATER INFLOW AND NUTRIENT ADDITION IN GALVESTON BAY, TEXAS, USA

The Galveston Bay Estuary Program identified an “examination of the impacts of freshwater inflow and bay circulation” as priority areas in its comprehensive conservation management action plan. The program’s goal was specifically to ensure beneficial freshwater inflows necessary for salinity, nutrient and sediment loading regimes adequate to maintain productivity of economically and ecologically significant species in Galveston Bay. The major gap in the present knowledge is a clear understanding of the downstream ecological impacts of changes to freshwater inflows on phytoplankton communities. Herein we present findings from studies performed in 2009 and 2010 in Galveston Bay which used phytoplankton pigments (measured using HPLC) as chemical biomarkers to measure the relative abundance of major phytoplankton groups throughout the Bay. We compared trends of water quality parameters (salinity, nutrients) and inflow data from USGS to determine environmental drivers. Multivariate statistical analyses were used to identify the major patterns in phytoplankton communities, including between different areas of the Bay and to assess responses to freshwater inflows (natural) and nutrient additions (experimental). Results show there were clear spatial and temporal patterns in the dominant phytoplankton groups which are tempered by inflows (natural) and nutrient additions (experimental). However, we found no statistical correlation between phytoplankton abundance and nutrient addition. The importance of nutrient addition did not induce a response in phytoplankton abundance which suggests adequate nutrients are available during these periods. This was not the case during summer months where the addition of nitrate stimulated diatom growth. This research demonstrates the importance of freshwater inflows as an underlying mechanism driving beneficial primary production in coastal communities.
A fundamental question posed in studies of nonnative and invasive species is which native populations have contributed to the populations in the nonnative habitat. The answer to this question is vital for mapping the invasion and clarifying the specific identity of the invaders. In this study, we examined genetic variation among six populations of Mytilus charruana, the charru mussel, within their native distribution along the South American coast and compared that variation to four populations recently discovered along the east coast of the United States. We sequenced 722 base pairs of the mitochondrial COI gene from 249 samples (approximately 25 samples/population) to evaluate the genetic relationship between native and nonnative populations. We evaluated levels of genetic diversity by determining nucleotide diversity and gene diversity among all populations and comparing native and nonnative collective diversities. Furthermore, we constructed a haplotype network using data from all populations to determine how differentiated the populations were from each other. We found that genetic diversities were consistently higher in populations from the nonnative habitat in support of the idea that non-native populations are comprised of multiple native populations (admixture). Our results also indicated that each population was comprised of haplotypes unique to that population and that populations were roughly grouped together based on location. The pattern of haplotype variation within the non-native U.S. populations was indicative of receiving migrants from multiple populations originating along the northern (Caribbean) coast of South America.

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DEVELOPMENT OF NITROGEN CRITERIA FOR MAINE'S COASTAL WATERS

The U.S. Environmental Protection Agency (EPA) published the National Nutrient Strategy in 1998 that described the approach for developing state-specific numeric nutrient criteria to meet water quality standards and the goals of the Clean Water Act. Over the past ten years, the Maine Department of Environmental Protection has primarily focused on development of nutrient criteria for freshwaters. More recently, physical, chemical and biological data collected by various environmental organizations have been compiled to enable preliminary analyses of water quality and biological response parameters relative to nitrogen concentrations within coastal waters. In general, ambient surface water data indicate that while the quality of Maine’s coastal areas remains high, selected embayments including Casco Bay and Penobscot Bay demonstrate locally elevated nitrogen concentrations, degraded water quality, and corresponding biological responses. Two independent studies completed for Maine DEP since 2008 have stressed the value of a data distribution method to assess the range of nitrogen concentrations within Maine’s diverse coastal waters relative to common water quality parameters (e.g., transparency, dissolved oxygen) and biological responses (e.g., chlorophyll a), as stratified by waterbody classification, ecosystem characteristics. Based on a legislative resolve enacted in 2007, the Maine DEP will complete draft nutrient criteria for coastal waters for stakeholder review by July 2012, with the final criteria development, legislative rulemaking, and anticipated approval by EPA Region 1 expected to require an additional three to five years.

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COMPARISON OF DENITRIFICATION AND ANAMMox ALONG VERTICAL SEDIMENT DEPTHS IN THE CAPE FEAR RIVER ESTUARY

Estuaries are one of the most productive ecosystems as a habitat of variety of animals and plants. However, excess nitrogen loading has led to eutrophication and hypoxia, triggering fish kills. Microbial nitrogen removal pathways such as denitrification and anammox (Anaerobic Ammonium Oxidation) are important to convert dissolved inorganic nitrogen to gaseous N species. However, spatiotemporal variability of both processes has not fully examined in estuarine ecosystems. By examining anammox and denitrification in different sediment depths at various sites, hot spots of microbial N removal processes, as well as geochemical features affecting both processes might be identified. Sediment samples and geochemical features of pore and bottom water were collected from 5 depths in the Cape Fear River Estuary over a salinity gradient through seasonal changes in 2010-2011. Potential denitrification and anammox rates were measured using 15N tracer incubation experiments. In general, denitrification rates were an order of magnitude higher than anammox rates, with highest rates often observed in the top 1 centimeter. % anammox varied significantly throughout site and depth in response to the reduction of denitrification rates. Seasonally, denitrification and anammox were highest in spring, followed by winter. Surprisingly, fall denitrification and anammox rates were on par with winter rates at oligohaline stations. The mesohaline station with the most tidal influence showed higher rates of denitrification and anammox in all three seasons. In this study, we found significant differences in both denitrification and anammox rates depending on their location (depth) in the sediment. Similar differences in rates were also observed, however there was no clear trend. Further analyses in microbial community structure and biogeochemical characteristics may be able to define a controlling factor of anammox and denitrification in estuarine sediments.

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WETLAND HYDROLOGIC IMPACTS RESULTING FROM SOUTHERN GOLDEN GATE ESTATES DEVELOPMENT AND RESTORATION ASSOCIATED WITH THE PICAYUNE STRAND RESTORATION PROJECT IN SOUTHWEST FLORIDA

Fakahatchee Strand and Picayune Strand were originally dominated by cypress forests and to a lesser extent by herbaceous wet prairies, with scattered islands of pine and hardwood forest. The natural hydrologic and fire regimes in Fakahatchee Strand have been influenced by drainage in surrounding land uses, but these regimes have been buffered by the large size of the Strand, which has left the forest interior reasonably intact. The severely altered hydrologic and fire regimes in Picayune Strand have resulted in a landscape that has been steadily shifting to upland communities dominated by palms, Sabal palmetto, while the remaining wetlands are becoming dense thickets of the exotic Brazilian pepper, Schinus terebinthifolius. Hydrologic monitoring across the main Fakahatchee Sandway has shown seasonal pre-restoration water table drawdowns of almost 2 m in the vicinity of the eastern most canal in Picayune Strand that borders Fakahatchee Strand’s western edge. The water table has been measurably lowered for a distance of over 1.5 km from the canal during the wet season when water levels are naturally above ground and to almost 5 km from the canal during dry periods when the water table is naturally below ground. Filling of the upper 3 km of the canal was completed in early 2004. The remaining 8 km were filled in 2006-2007. During the past four wet seasons, we have seen partial restoration of wet season overland flows in the eastern portion of Picayune Strand. Based on a comparison of data from monitoring wells near a filled canal and other wells near an unfilled canal that is 3 km west of the filled canal, we are seeing increased hydroperiods and wet and dry season water levels in both Fakahatchee and Picayune Strands. However, because of the distance over which canals affect water levels in this area, we will not see complete hydrologic recovery of this area until several other nearby canals that are part of the Picayune Strand Restoration Project have been filled.

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TOWARDS A DISTRIBUTED HYDROLOGIC MODELING FRAMEWORK FOR THE CHESAPEAKE BAY WATERSHEDS

The evaluation of ecosystem and watershed services such as the detection and attribution of the impacts of climate change provides one of many examples of the growing need for high resolution, spatially explicit resource assessments. Clearly, it requires the development of a framework and associated tools that can efficiently transfer (data processing, processing and assignment) various high-resolution national data products (such as SSURGO for soil, NLCD for land cover etc.) and associated parameters to the watershed model. Moreover, a large-scale distributed model application would require solving millions of ordinary differential equation associated with multiple hydrologic states. Therefore, the data (in terms of processing, storage and efficient retrieval), model (in terms of solution of a fully coupled multi state system) and model-data integration (in terms of development of a shared geo-database and parameter assignment) makes the overall modeling system a complex high-performance-computing problem. This research outlines the formulation and multi-scale application i.e. hill-slope (10-100m) to catchment (100-1000m) to synoptic scales (>100km) of Penn State Integrated Hydrologic Modeling System (PHIM). It also outlines a strategy towards the implementation of the spatially distributed physics based hydrologic modeling framework to the Chesapeake Bay Watersheds to a test bed at Juniata River Basin, PA.

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ENVIRONMENTAL N:P RATIOS AND PHYTOPLANKTON PRODUCTIVITY: EFFECT OF RESIDENCE TIME AND TYPE OF N

The effect of varying nutrient ratios (and especially N:P ratios) on phytoplankton productivity in aquatic ecosystems will depend upon both the nature of the system and the composition of the N. The dissolved inorganic nitrogen (DIN) fraction is made up of ammonium, nitrate and nitrite. Often urea-N is included in the N fraction as it is easily
decomposed to ammonium or even taken up by phytoplankton directly. Generally the Redfield ratio of 16N:1P is invoked to evaluate the nutrient most likely to become limiting. In an ecosystem with long residence time, and a non-Redfield nutrient ratio, one nutrient will be exhausted first and will be designated as the limiting nutrient. In the long residence time scenario, if P is elevated above Redfield, all forms of N are likely to be used, although at different rates as each are accessed over time. Enclosure experiments are an example of the long residence time scenario and may mimic the function of some ecosystems such as coastal lagoons. However, in low residence time systems with a continuous supply of nutrients, some fractions of N may be inaccessible and as a consequence, the ecosystem may be forced into an alternate steady state with changes in phytoplankton species composition and primary production. One such example is San Francisco Bay where high anthropogenic inputs of ammonium inhibits the uptake of nitrate by the phytoplankton resulting in reduced diatom populations and reduced primary production.

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TOWARDS A SYSTEMATIC, BENEFIT-EVALUATION APPROACH TO ASSESSING CHANGE, AND DRIVERS OF CHANGE, FOR TIDAL WETLANDS

There is ample evidence that diminishing tidal wetland areas provide fundamental and highly beneficial ecosystem services like carbon capture and storage, shoreline stabilization, and habitat/massary function. Despite these significant benefits across regional landscapes and in specific locations, missing from coastal assessment tools is a means to evaluate and quantify such values. And, there is no systematic and encompassing strategy for assessing and monitoring habitat condition for rehabilitating ecosystems and restoring benefits. Current global assessments focus primarily on declining area and increasing loss, along with serious threats to biodiversity. Each of these is extremely important, fuelled by a concern, but the missing assessments are arguably even more worrying. By all accounts, habitat condition and benefits continue to deteriorate despite efforts to protect key areas— a situation that will be exacerbated by climate change. Where we want to preserve important mangrove ecosystems into the future, there is an urgent need now to identify and quantify key stressors, particularly anthropogenic ones. But, apart from counting species present and measuring canopy density, we have few assessment protocols for monitoring declining habitat condition and identifying stressors. And, there is no standardisation of methods. What is needed urgently is an agreed standard protocol that can distinguish changes due to natural variation compared with the myriad human pressures. In this way, we might then be able to target particular human stressors to enhance resilience for the increasingly more frequent and damaging natural pressures. We propose such a categorisation scheme, coupled with an evaluation system (like SVAM, for estuarine shorelines) that classifies all conceivable drivers, and identifies expected and observed ecosystem responses. And, this works where the response indicators are then used to identify drivers of change.

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LONG-TERM CHANGES IN SEAGRASS COMMUNITY STRUCTURE IN THE WESTERN GULF OF MEXICO: LINKAGES TO HYDROGRAPHY AND REGIONAL CLIMATIC EVENTS

The focus of our study was to examine how changes in local climatology have influenced a seagrass community in the western Gulf of Mexico over the past two decades. We measured biomass and calculated root:shoot ratios of shoal grass, Halodule wrightii, against several biotic and abiotic variables over a 22-year period (1989-2011) at a site (LM-151) in the upper Laguna Madre. These indices included monthly measurements of dissolved inorganic nitrogen, salinity, water temperature, and water column chlorophyll. An in situ spherical quantum light sensor continuously measured photosynthetically active radiation (PAR) at canopy height. Data revealed an overall increase of 0.8 °C in water temperature over the 22-year period (n = 288). The increase in winter water temperature minima may have influenced the recent spread of the seagrass Syringodium filiforme in the upper Laguna Madre; minimum winter water temperatures rose by 2.7 °C between 1989 and 2011. Salinity ranged from 20 to 55 % and we suspect that trends in seagrass biomass are associated with a salinity regime that fluctuates between highs and lows on a cycle every 4-6 years—characteristic of freshwater inflow (FWI) events caused by El Niño-Southern Oscillation (ENSO) phenomena. Water chlorophyll levels reflect these periodic run-off events, and we propose that PAR, and thus biomass, are limited by an FWI-driven regime. Consequently, variations in seagrass community structure and productivity are valuable response indicators to long-term changes in regional climate.

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EVALUATION OF HYDROMULCHING AS AN ESTABLISHMENT TECHNIQUE FOR BACCHARIS HALIMIFOLIA AT COASTAL RESTORATION SITES

Development of rapid vegetation establishment techniques for use at barrier island and other coastal restoration sites is critical to project success and sustainability. We investigated various limitations on natural establishment as well as a novel establishment technique for the woody shrub, Baccharis halimifolia, on restored barrier island swale habitats. Our methods focused on improving both B. halimifolia germination as well as soil conditions for subsequent vigorous growth. We conducted a series of experiments to meet these objectives. The first study determined burial depth limitations for B. halimifolia seed germination, whereas the second study elucidated the benefit of organic matter and hydromulch amendment on B. halimifolia seed germination under two precipitation regimes. Our third experiment determined germination success of B. halimifolia seed/hydromulch slurry in response to equal weekly rainfall amounts applied using two differing application rates and two light levels. Results from the first study indicate that B. halimifolia seed germination is reduced with any burial. The second study revealed a significant benefit of hydromulch on germination in sediment with low organic matter, whereas in the absence of hydromulch, sediment organic matter content was positively associated with germination success. Results from the third study indicate that field applications of hydromulch/B. halimifolia seed slurry require a subsequent rainfall event to induce successful germination, as water content present in the initial hydromulch application is not sufficient to induce a germination response. The optimal conditions such as burial depth, precipitation regime and light levels indicated by these studies may be useful for improving establishment of B. halimifolia at coastal restoration sites.

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DIURNAL VARIATION IN CHLOROPHYLL FLUORESCENCE OF THALASSIA TESTUDINUM SEEDLINGS IN RESPONSE TO CONTROLLED SALINITY AND LIGHT CONDITIONS

Pulse amplitude modulation (PAM) fluorometry is a non-destructive method for measuring photosynthetic health of terrestrial and marine plants. However, diurnal variability in chlorophyll fluorescence due to dynamic irradiance conditions is an important issue when using PAM fluorometry to measure physiological conditions of plants at the landscape scale. We examined the use of slopes and y-intercepts of diurnal effective yield (AF/Fm’) vs. photosynthetically active radiation (PAR) regressions rather than absolute AF/Fm’ values to assess physiological status of Thalassia testudinum seedlings in a controlled mesocosm study. Photosynthetic characteristics were quantified using a Mini PAM fluorometer (Walz, Germany) while the seedlings were exposed to two light treatments (50-70% reduction and full sun) and three salinity treatments (20, 35, 50). Measurements were taken at 0600, 0900, 1200, 1500, 1800, and 2100 h in order to assess the diurnal variation in chlorophyll fluorescence yields and PAR, with measurements at 0600 and 2100 providing maximum quantum yields (Fv/Fm). Results indicated a significant light and salinity effect for regression y-intercept and measured Fv/Fm values, with shaded seedlings having higher values for both parameters suggesting low-light acclimation; the highest salinity treatment resulted in significant reductions for both parameters, suggesting stress. Slopes of AF/Fm’ vs PAR significantly differed with varying light treatments, with full sun seedlings exhibiting a lower slopes than shaded seedlings,indicating higher efficiency of dissipation of excess energy (photoprotection) in the sun versus the shade treatments. These experimental results suggest that AF/Fm’ vs. PAR regressions are responsive to changes in the physiological status of Thalassia testudinum seedlings.

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CHANGES IN LEAF SPECTRAL REFLECTANCE OF THALASSIA TESTUDINUM SEEDLINGS IN RESPONSE TO SALINITY VARIATION AND LIGHT REDUCTION

Spectral reflectance (R) is an apparent optical property that is widely used to nondestructively assess changes in pigment composition as a response to stress in plants. In this study R’s of Thalassia testudinum seedlings collected from Biscayne Bay, Florida were measured at the termination of a 5-week salinity (50, 35, 20) versus light (unshaded versus 50% shade reduction) mesocosm experiment. Non-parametric multidimensional scaling analyses of reflectance spectra indicated a stronger salinity-based versus light-based clustering of the reflectance spectra. Two-way analysis of similarity (ANOSIM) indicated that salinity 50 treatment spectra were significantly different than both salinity 35 and 20 treatments, which were not significantly different from each other; differences between light treatments were also not significant. Similarity percentage procedures (SIMPER) indicated that the optimal wavelengths for discrimination among salinity treatments were 540-560nm and 650-690 nm.
Normalized difference vegetation indices (NDVI) and red-green ratios were highest, while the photochemical reflectance index (PRI) was lowest, for the salinity 50 treatment. These results suggest the hypersalinity affects both chlorophyll and carotenoid contents of *Thalassia testudinum* seedlings to a greater extent than hypersalinity and that spectral reflectance and reflectance indices may be used to nondestructively assess hypersalinity stress in this species.

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**WORLD-WIDE TYPOLOGY OF NEAR-SHORE COASTAL SYSTEMS: HOW TO DEFINE AND APPLY THE COASTAL FILTER OF RIVER INPUTS TO THE OCEANS**

We present a spatially-explicit global overview of near-shore coastal types, based on hydrological, lithological and morphological criteria. A total of 4 main operational types act as active filters of both dissolved and suspended material entering the ocean from land: small deltas (type I), tidal systems (II), lagoons (III) and fjords (IV). Large rivers (V) largely bypass the near-shore filter, while karstic (VI) and arctic coasts (VII) act as inactive filters. This typology provides new insight into the spatial distribution and inherent heterogeneity of estuarine filters worldwide. The relative importance of each type at the global scale is calculated and types I, II, III and IV account for 32, 22, 8 and 26% of the global coastline, respectively, while 12% have a very limited near-shore coastal filter. Applications of this typology can be found in various fields related to coastal sciences at local, regional or global scales (e.g., budget calculations, model parameterisations, scaling of local estimates). Examples include (i) a re-estimate of the global estuarine surface area to 1.1 106 km2 instead of 1.4 106 km2 in earlier work, (ii) a spatially explicit model for the coupled nitrogen (N) and phosphorus (P) cycles to quantify the role of estuarine waters as a filter for terrestrial nutrient fluxes, and (iii) the exchange of CO2 between the atmosphere and the global coastal ocean using a scaling of air-water CO2 fluxes and a typology for continental shelf seas including (a) enclosed shelves, (b) coastal upwelling systems, and (c) open continental shelf areas, ranked by climatic zones.

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**EVALUATING SPATIAL GOVERNANCE INITIATIVES**

The policy shift toward the use of spatial management tools in American ocean governance is just beginning. A few states have adopted legislation and have begun to implement it, while others are still in the design phase. Although Congress has not yet passed any legislation, Federal agencies are attempting to develop a joint spatial management system based on the recommendations of the Interagency Ocean Policy Task Force. At this early stage in what might turn out to be a significant shift in ocean policy, it is worth thinking about the ways in which we might evaluate various initiatives. To date, evaluation opportunities have been limited to theory-based assessments of alternate management structures. In the relatively near future, we will have the opportunity to assess the effects of these structures on people and natural resources. Because initiatives will necessarily be so different in the large and small details of their structure, the assessment process presents an obvious, important, and fleeting opportunity for learning. This presentation is an attempt to begin the conversation about which evaluation metrics might be appropriate, what kinds of data collection should be prioritized, and the proper time horizons for studying the range of possible outcomes resulting from a shift to spatial management.

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**HOW SOON DO YOU BECOME WHAT YOU EAT? A STABLE ISOTOPE FEEDING EXPERIMENT WITH AMERICAN EELS (*ANGUILLA ROSTRATA*)**

The carbon and nitrogen stable isotope values (δ13C and δ15N) of a consumer can vary according to the food sources at the base of the food web, changes in isotope ratios as prey is assimilated (i.e., turnover) and variation in the rate at which the isotope ratio of the diet itself. Eel-specific fractionation factors and turnover rates can be used to more accurately estimate the food sources and trophic position of field-collected eels. Increased understanding of eel resource use over time can aid in the conservation of this declining species.

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**ASSESSING FUNCTIONAL EQUIVALENCY OF RESTORED, NO-TAKE OYSTER REEFS**

A key goal of habitat restoration is functional equivalency in demographic rates compared to natural habitats. We quantified oyster demographic rates (density, fecundity, growth & survivorship) within a net-work of no-take oyster (*Crassostrea virginica*) broodstock reserves that were created in Pamlico Sound, North Carolina, USA to help augment larval supply to fished areas. Over a 3-year study period, oyster recruitment (135-1100 oysters m-2) and total density of legal-sized oysters (169 m-2) increased fifteen- and five-fold, respectively, and total oyster densities were, on average, ~1200 m-2. Baseline and no-take reserves studied here appear to be a resounding success. The protection of oyster populations from harvest via constructed no-take reserves seems a viable approach to attain functional equivalency in demographic rates for restored oyster populations.

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**ZOOPLANKTON COMPOSITION ACROSS ENVIRONMENTAL GRADIENTS IN THE NORTHERN GULF OF MEXICO**

The Northern Gulf of Mexico (NGOMEX) is home to one of the world’s largest zones of coastal hypoxia. We measured hydrographic conditions and zooplankton taxonomic composition during annual cruises in the NGOMEX at the height of the hypoxic season (July-August 2003, 2004, and 2006-2008). Using multivariate analyses, we identified five groups of co-occurring zooplankton taxa and estimated the optimal hydrographic conditions for occurrence of each. The strongest predictors of taxon-specific zooplankton abundances, in decreasing order, were salinity, proportion of the water column that was hypoxic (vertical extent of hypoxia), temperature, and oxygen concentration at sample depth. The numerically dominant co-occurrence group consisted of six copepod species and salps. Highest abundances in this group were associated high salinity and greater vertical extent of hypoxia than for most other zooplankton species. The second most abundant group, characterized by the copepod *Acartia tonsa*, was associated with warm, low salinity, and well oxygenated waters (e.g. within river plume). Optimal conditions for most other taxa were at intermediate to high salinity, low to intermediate vertical extent of hypoxia, and intermediate values of dissolved oxygen. These results will be discussed in terms of inter-annual and broad spatial patterns in hydrography and zooplankton composition, and also with reference to the ecology of the zooplankton taxa seen.

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**THE SIZE OF FOOTPRINTS OF IMPACT AND THE PATTERN OF THE TRAJECTORIES OF RECOVERY FROM ANTHROPOGENIC STRESSORS IN ESTUARIES AND MARINE AREAS – PATTERNS AMONGST ECOCLOGICAL COMPONENTS**

In estuaries and the marine environment, the footprint of an impact due to an anthropogenic stressor has an extent and magnitude proportional to the intensity of the stressors and the sensitivity of the receiving environment. Secondly, it is hypothesised that the determination
of effect is dependent on the complexity and variability of the component or habitat being influenced by the stressor such that environmentally or ecologically variable systems require a greater stressor in order to manifest a change. Furthermore it is hypothesised that the speed of recovery from the effects of the stressor is dependent on the turnover rate of the ecological components being affected by the stressors and the timing of the removal of the action of the stressor. Using a large literature database, this paper tests these questions and indicates that community measures of components with rapid turnover times, such as the benthic meiofauna, have relatively rapid recovery times compared to long lived components such as the estuarine and marine fish community. It also discusses the recovery trajectories of estuaries compared to marine areas. The paper then presents a conceptual model linking the footprint and trajectory of recovery for environmental stressors such as organic enrichment, persistent pollutant exposure, sediment modification due to dredging/ dredged material disposal and infrastructure placement. The paper ends by proposing a set of paradigms relating to these aspects.

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ARE FISH EFFECTIVE INDICATORS OF INTERTIDAL HABITAT QUALITY?

In order to achieve early detection of anthropogenic disturbance, one should select indicators that are sensitive to the perturbation, and that can provide unambiguous evidence of an impact distinguishable from the effects of natural environmental variability. Delayed detection of disturbance may exacerbate damage and make mitigation efforts more difficult. Given their economic importance, fish are increasingly employed as indicators of general habitat quality. However, few studies have attempted to link spatially limited anthropogenic changes in the vegetated intertidal margins of estuaries to the state of the population of fish found there. Through a manipulative field experiment, we examined the efficacy of intertidal fish assemblages as an indicator of mangrove canopy damage caused by horticultural pruning. Our results, coupled with the findings of a literature review, give us reason to question the ability of fishes to serve as sensitive indicators of intertidal habitat quality in mangroves and salt marshes.

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ROLE OF PLANT STRESS, FUSARIUM, AND MARSH CRABS IN SUDDEN VEGETATION DIEBACK

Sudden Vegetation Dieback (SVD) is the loss of smooth cordgrass (Spartina alterniflora, SA) along intertidal creeks in salt marshes of the Atlantic and Gulf states. The precipitating cause(s) of SVD remain(s) unclear. A three-year survey of SVD sites in CT and MA found a higher incidence of a newly described endophytic fungus called Fusarium palustre than in healthy marshes. Transplanting healthy plants into two SVD sites resulted in recovery in one site and no recovery in another. The incidence of F. palustre was slightly greater where there was no recovery from SVD. Inoculation of healthy plants caused lesions, but no mortality was observed unless plants were stressed by drought. Many SVD sites also suffered herbivory from the blue marsh crab (Scardarma reticulatum). When SA plants were grown for two years in exclusion cages in an SVD site, plants were larger than uncaged plants. When all plants were heavily colonized by F. palustre. Pitfall trapping of the blue marsh crab in 2009 and 2010 did not statistically differ between an SVD site that had recovered and a site that had never recovered from SVD. Densities of Uca spp. and Carcinus spp. were found in greater numbers in SVD sites that showed no recovery than sites that had recovered. It was hypothesized that SA stressed by drought and disease might predispose SA to be more susceptible for herbivory by purple marsh crabs. Pairwise feeding studies with healthy SA plants or plants stressed and inoculated with F. palustre were set in bins where purple marsh crabs were reared in captivity. Estimates of herbivory (number of grass blades cut) was significantly greater on drought-stressed, diseased plants than on healthy plants. These findings suggest that F. palustre and S. reticulatum may increase in marshes where a stress event has previously occurred.

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VEGETATION COMPLEXITY AND PLANT SPECIES RICHNESS IN A TIDAL FRESHWATER MARSH

Physical and biological complexity affects processes at community and ecosystem levels of organization. In tidal wetland habitats, physical and biological complexity interact to increase the number of niches and their occupation by species, which in turn influence ecosystem processes such as productivity, nutrient cycling rates, and sediment dynamics. Therefore, understanding variation in complexity is key to designing successful wetland restoration and predicting the response of wetlands to environmental change such as sea level rise. Spatial variation in physical and biological complexity have recently been advanced using LiDAR (Light Detection And Ranging) remote sensing data, which provides a spatially continuous representation of physical structure in 3 dimensions, but it is unclear how the measured measures of complexity. This is particularly true for tidal freshwater marshes (TFM) vegetation where small variation in topography and physical structure can be related to large variation in plant community composition and ecosystem processes. Using detailed field observations and small-footprint discrete LiDAR, we investigated the comparability of remote and field-based measures of physical and biological complexity of a TFM near Alexandria, VA. We found that LiDAR measures that capture the height-integrated density of vegetation were best correlated with measures of biomass and light penetration to the marsh surface. We also found these same measures to be linearly related to species richness and abundance. LiDAR provides an inadequate measure of maximum vegetation height (almost universally missing tall, isolated plants) and micro-topography. In combination, our results provide new insight into the spatial processes controlling physical and biological complexity, and in conjunction with data on how complexity influences sedimentation and erosion over time, would inform predictions of marsh response to sea level rise.

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INITIATION OF INTENSIVE LONG-TERM WETLAND MONITORING IN THE DELAWARE ESTUARY AND BARNEGAT BAY, MID-ATLANTIC, USA

Climate change, sea-level rise, and coastal development are only a few of the factors affecting tidal wetlands. How wetlands will change in area, composition, and function over time in response to the interactive influences of these factors is relatively unknown. A scarcity of long-term wetland monitoring data limits our ability to assess changes over time and predict future adaptation or loss of area and function. To address physical, chemical, and biological changes over time, we have established six wetland monitoring stations in the Delaware Estuary and three in Barnegat Bay. Beginning in 2010, changes in surface elevation, elevation relative to sea level, soil and water chemistry, surface chl a, plant biomass, plant communities are being monitored at each of the fixed stations. The network of monitoring sites include tidal freshwater, brackish, and salt water wetlands, wetlands along a coastal plain estuary (Delaware Estuary) and a coastal lagoon and barrier island (Barnegat Bay), and sites that span nutrient gradients. While initial data reveal apparent site differences, long-term data are expected to result in a better understanding of the interacting affects of factors such as elevation, sedimentation, and nutrients on wetland change over time.

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THE EFFECTS OF PHRAGMITES INVASION, TIDAL RESTRICTION AND MARSH RESTORATION ON THE GREENHOUSE GAS EMISSIONS IN A NEW ENGLAND SALT MARSH SYSTEM

New England salt marshes have a long history of being dammed, drained, and filled to make way for human development. Many tidally restricted marshes have been overtaken by the invasive common reed Phragmites australis, a plant that thrives in disturbed areas and often outcompetes native species like Spartina spp when tidal influence is removed and salinity drops. Phragmites, like other invasive species, can change the carbon and nitrogen cycling of the areas it invades. Therefore some marshes have been doubly affected: not only has the tidal regime change affected their biogeochemistry, but invasive Phragmites has as well. In an effort to undo these actions the restoration of salt marsh tidal flow has become a common undertaking in the management of public land. To better understand the impact of tidal restriction and restoration we studied the influence of Phragmites on New England salt marshes we measured greenhouse gas (CO₂, CH₄, N₂O) fluxes in Phragmites and native species stands. Preliminary measurements of the airspace within Phragmites stems suggest that these plants are potential hot spots for CO₂ (507 ppm to 3.16%) and CH₂ (1.17 ppm to 81%). But not N₂O. Concentrations were on average 20 (CO₂) and 300 (CH₄) times higher than atmospheric levels. In addition, we will discuss our results from closed chambers that were deployed in a factorial design across marshes with and without Phragmites invasion, restriction and restoration. In the face of global climate change, it has become particularly important to quantify the emission and uptake of the three most powerful greenhouse gases (CO₂, CH₄ and N₂O), all of which are produced in the biogeochemical processes taking place in salt marshes. Since Phragmites invasion, tidal restriction and marsh restoration are ongoing, it is necessary to account for the effects these changes will have on greenhouse gas emissions both when making management decisions and when calculating coastal carbon budgets.
Environmental Conditions in Northern Gulf of Mexico Estuaries: Before and After the Deepwater Horizon Oil Spill

When conducting an environmental assessment to determine the ecological effects of the Deepwater Horizon (DWH) Oil Spill in the Gulf of Mexico (GOM), baseline environmental data is essential to establish ecosystem condition prior to the incident. EPA’s National Coastal Assessment (NCA) monitored the ecological condition of estuaries in the GOM annually from 2000 to 2006, providing a historical baseline for water quality, sediment quality and biological condition in northern GOM estuaries, prior to the DWH Oil Spill in 2010. This assessment was based on summer season measurements of nutrients, chlorophyll, dissolved oxygen, water clarity, sediment chemistry and toxicity, total organic carbon, benthic macroinvertebrate communities, and fish tissue contaminants. Immediately following the DWH explosion, EPA Regions 4 and 6 mobilized teams to collect samples in estuaries before oil and oil-related contaminants were transported into nearshore environments. This oil spill response monitoring effort provided more recent data for water and sediment chemistry in northern GOM estuaries prior to exposure to contaminants from the DWH Oil Spill. EPA continued its monitoring efforts through fall 2010 as the region became exposed to oil-related contaminants to determine extent of exposure and potential ecosystem effects from the DWH Oil Spill. In addition, the National Coastal Condition Assessment (NCCA) was conducted in summer 2010 to provide an assessment of ecological conditions using water quality, sediment quality, and biological condition indicators similar to those employed by EPA. Comparisons of water and sediment chemistry data from these surveys show evidence of limited, local exposures to oil-related contaminants in GOM estuaries. Benthic macroinvertebrate data from NCA and NCCA will be compared to determine potential ecological effects related to the DWH Oil Spill.

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Hydrodynamics and Coastal Inundation in a Tropical Coastal Lagoon Surrounded by Vast Mangrove Regions

The hydrodynamic variability due to sea level changes, wind forcing and structural changes (from human activities) in a tropical coastal lagoon was investigated using a 2D numerical model. The Chelem lagoon in the northeastern coast of the Yucatan peninsula is a shallow system surrounded by large wetland areas and is highly used for tourism and commercial activities being also shelter for the fishery industry, the local nasy and recreational boats. During the last decades the natural system has suffered important morphological changes from human activities. A 10 day field campaign was performed to collect detailed bathymetric data as well as water level variations and current measurements form instruments installed at selected points inside and outside the system to force and validate the numerical model. The validated model shows the circulation patterns and inundation areas during normal tidal variations. The mangrove health is highly sensitive to the regular inundation patterns. There is clear evidence of important hydrodynamic variations due to wind forcing, especially during intense events from the East which coincide with the principal (W-E) axis of the coastal lagoon. The low topography of the region results in large inundated areas when the tide is increased. Additionally, the study shows important hydrodynamic changes resulting from dredging and dumping activities and the severe circulation restriction resulting from a road built dividing nearly half lagoon with a rigid structure. These modifications have large impact in the water quality and ecosystem health of the whole region.

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Fighting Eutrophication

For decades eutrophication has affected the water quality in coastal areas worldwide and the ecosystem function, with changing benthic community and potential changing habitat for a number of organisms. In many countries much effort has been put into reducing loadings of nitrogen (N) and phosphorus (P), and with the European Water Framework Directive (WFD), this effort has increased significantly in several countries. In Denmark the 3rd generation of water plans is in public hearing – water plans which are supposed to make the ecological condition of estuaries fit for the economic sector. Until now positive response in coastal and open waters has been very modest. This raises the question when enough is enough? To this end we carried out substantial modeling and data analysis as part of the agricultural effort to question the latest reduction goals (19,000 tons N) set by the Danish authorities. One study focused on responses in an estuary and another study on responses in the open inner waters. The models gave some indications on what is to be expected, but neither models nor data analysis predicted substantial improvements. Furthermore, both models and an independent analysis based on monitoring data suggest that boundary waters (for many authorities) have an unexpected high influence. Lessons learned are: 1) local Danish reductions of e.g. 19,000 tons N will have insignificant effects in open waters when external exchange amounts to 500,000-600,000 tons N, 2) prior to implementing water plan reducing the yearly income of a sector by US$ 1 bill, spend some money on detailed assessment, e.g. by using numerical models.

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Hurricane Impact on Mangrove Tree Crab Populations in Florida

Hurricane impacts are of special interest to mangrove ecologists given the current state of climate change and the ecological and economic services that these habitats provide. Mangrove forests serve as habitat and shelter for numerous animal species, many of which play an important role in ecosystem function and are of considerable commercial value. They reduce storm surge and wind damage, protecting inland habitat and development. They also trap sediment in their extensive root networks, reducing land subsidence along coastlines. In 2004, the east and west coasts of Florida were hit by 4 hurricanes that significantly impacted coastal vegetation including fringing mangrove populations. This study examines how populations of one of the most abundant animal species within mangrove forests, the semi-terrestrial mangrove tree crab (Avato pisonii), were impacted. Through feeding activity, A. pisonii processes mangrove leaves making them available to the detrital food web, which contributes to the diet of mangrove residents as well as offshore species using mangroves for shelter or food. Avato pisonii also is preyed upon by fish, birds, and raccoons. Hence, examining how its population was affected by these major hurricanes is important given its ecological role in its environment. Crab populations were tracked for 1.5 years post disturbance in natural and impounded mangrove stands. There were no immediate negative impacts of the hurricanes on crab density. Instead, typical seasonal variation in crab density was found after the storms, especially in impounded stands. While crab population density remained high during the summer (active season) of 2005, it was depressed during the summer of 2006.

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Using Remotely Sensed Data and Hydrologic Models to Evaluate the Effects of Land Use and Climate Change on Hydrologic Processes and Shallow Aquatic Ecosystems

Alabama coastal systems are subject to increasing pressure from a variety of activities including urban development and climate change. Land cover/land use (LCU) and climate changes have a direct effect on the discharge of rivers that drain into Mobile Bay and adjacent coastal water bodies. The outflows change water quality (temperature, salinity, and sediment concentrations) in the shallow aquatic areas and affect ecosystem functioning. Mobile Bay is a vital ecosystem that provides habitat for many species of fauna and flora. Historically, submerged aquatic vegetation (SAV) and seagrasses were found in this area of the northern Gulf of Mexico; however the extent of vegetation has significantly decreased over the last 60 years. The objectives of this research are to determine: how LCU and climate changes affect runoff and water quality in the estuary; and how these changes will affect habitat suitability for SAV and seagrasses. Our approach is to use watershed and hydrodynamic modelling to evaluate the impact of land use and climate change on shallow water aquatic ecosystems in Mobile Bay and adjacent areas of coastal Alabama. Remotely Sensed Landsat data were used for current LCU model input and the Prescott Spatial Growth Model was used to generate future scenarios. The data provided by Intergovernmental Panel on Climate Change (IPCC) of the future changes in temperature, precipitation, and sea level were used to create the climate scenarios for the modelling Project results are being shared with Gulf coast stakeholders to benefit coastal policy and climate change adaptation strategies.
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MOLTS REVEAL LIFE-HISTORY PATTERNS OF AMERICAN HORSESHOE CRAB POPULATIONS IN FRINGE HABITATS

Horseshoe crab (Limulus polyphemus) molts were collected from an intertidal marsh and beach areas adjacent to known spawning sites on Taunton Bay in Franklin, Maine and the north side of Petit Bois Island in the northern Gulf of Mexico (nGOM). Molts were collected, measured, and sexed approximately every 2 weeks to 1 month corresponding to full and new moon low-tides at both sites. Data collection periods for the Maine site were August – Oct. in 2005 and 2006 and in the nGOM Mar – Aug 2008 and May - Aug 2009. Molts were characterized for each survey and by year in terms of abundance and size (prosomal width) measurements. Sex ratios were determined and statistical comparisons made by male, female, and unknown categories. In Taunton Bay, 245 total molts ranging in size from 18.7 to 165 mm were found. nGOM surveys yielded a total of 793 molts ranging in size from 1.5 to 152 mm. The annual M:F population ratios in Taunton Bay were 1.27 in 2005 and 2.62 in 2006; and at the nGOM site, 2.77 in 2008, and 2.25 in 2009. Sex ratio was generally independent of sampling date, indicating molt timing is similar for males and females. Temperature data in the respective study sites was evaluated to better understand environmental influences on abundance and growth trends. The molt data can be further applied to define cohorts and estimate rates of growth and molting. By serving as a proxy for size and number of living individuals in a population just prior to molting, molts provide important information on population dynamics that can be difficult to directly measure. This method may be applied broadly to other areas such as populations in Downeast Maine that are difficult to study because of water depth, turbidity, and temperature, other fringe areas such as nGOM where horseshoe crab populations are unknown, and to assess subadult crabs that are generally difficult to capture because they are smaller than adults and more highly mobile than younger crabs.

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HIGH RESOLUTION OBSERVATIONS OF WETLAND SHORELINE CHANGE IN THE ALBEMARLE-PAMLICO ESTUARINE SYSTEM (APES)

Shoreline erosion has been recognized as a problem with important human and ecological ramifications in coastal zones. Previous studies have typically focused on oceanfront shorelines and long-term changes. The goal of this research was to quantify changes in estuarine wetland shorelines over short time periods (months to years) and, specifically, associated with individual storm events. Five sites were chosen across the APES to represent a range of wetland types and locations. These sites were digitized using aerial photography according to a methodology established by the NC Division of Coastal Management. To determine a current shoreline position in the field each site was surveyed during summer 2010 using an RTK-GPS. Sites were reoccupied on a bi-monthly basis from August 2010 to July 2011 and following storm events. A balloon aerial photography system was also employed to image the shoreline. Shoreline change was analyzed for each time-step and methodology (RTK, balloon images, and on-screen digitizing) using the method of Cowart et al. (2008). Rates of shoreline erosion determined from the on-screen digitizing were found to be similar to previous work. The bi-monthly RTK-GPS surveys varied greatly both spatially and temporally. Accretion was locally measured at several of the study sites, but generally, net erosion dominated. Comparisons of the images acquired from the balloon aerial photography system indicate the importance of shoreline type and composition on the measured change. Rates of change were also determined for an individual storm event in September, 2010, Hurricane Earl. Again the results were spatially variable; however two sites (both exposed to the large fetches of Albemarle and Pamlico Sounds) experienced significantly higher erosion than was observed at any other point in the study. This study highlights the utility of combining high temporal resolution GPS surveys with aerial photography to examine the dynamics of wetland shoreline change.

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EELGRASS (ZOSTERA MARINA) RESTORATION IN MASSACHUSETTS BAY

The Massachusetts Division of Marine Fisheries is restoring two acres of eelgrass (Zostera marina) to sites in Massachusetts Bay, including Boston Harbor and Salem Sound. We are targeting sites that rated well in a GIS based preliminary transplant suitability analysis as well as a field based final site selection analysis. Site selection criteria include thresholds for sediment grain size, light availability, conflicting uses and percent survival of transplanted test-plots. We plan to investigate topics such as the efficiency of various transplant methodologies, optimal time-of-year for transplanting, assessment of sediment parameters in relation to eelgrass restoration, and the regulatory feasibility and effectiveness of using alternative mitigation (i.e. low impact moorings), for direct eelgrass impacts. Transplant methods will include the horizontal rhizome method as well as newer methods currently in use by researchers on Long Island Sound; the use of rocks to anchor shoots and shoots woven into burlap disks. The project is funded as mitigation for the 2002 construction of the Algonquin HubLine natural gas pipeline which destroyed a section of an eelgrass bed in Salem Sound.

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SOCIOECONOMIC CHANGES CAN AFFECT MANGROVE BIOGEOGRAPHY

Mangroves in less-developed countries often provide important ecosystem services to people who live subsistence lifestyles. On the Pacific island of Kosrae, Federated States of Micronesia, the use of some of these ecosystem services is declining. This could be a positive trend, but it may eventually make mangrove forests more vulnerable. For instance, mangrove firewood is being gradually replaced by kerosene for cooking food, and cheap imported concrete blocks reduce the use of mangroves for building materials. With less need to go into a mangrove forest, fewer young people know the names and uses of common mangrove plants, and as they get older fewer still will have experienced the range of ecosystem services the forest can provide. Elsewhere, such as in South Asia and Latin America, increased population pressure from people moving into coastal communities has led to conflicts among users of different ecosystem services, some of them species-specific. These conflicts may also break down traditional ecosystem management regimes. Other activities, such as planting mangroves offsite, may threaten the integrity of other coastal ecosystems and future provision of their ecosystem services. Information and educational programs on conservation and land use regulation in coastal landscapes may be most effectively delivered by local residents in order to internalize information about local species complements.

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COQUINA DONAX VARIABILIS AS INDICATORS OF COASTAL PAH POLLUTION ALONG SANDY BEACH SHORELINES

Coquina clams (Donax variabilis) are wondrously variably pigmented small filter feeding bivalves found in the intertidal zone of sandy beaches along the southeastern Atlantic and Gulf of Mexico coasts of the United States. With the impact of crude oil from the BP Macondo 252 (MC252) well failure on Florida panhandle beaches during June and July of 2010, concerns were raised about dissolved components of the oil. UWF began a monitoring plan, for alkane early on, and polyaromatic hydrocarbons (PAHs) after the alkanes disappeared, in the sand and water of local beaches. The need for a biological indicator of PAHs reflecting impact to biota and food webs became apparent, and the Coquina were targeted as surrogates in the context of the international Mussel Watch approach. Collections documented population variability spatially and temporally, and provided tissues for extraction and analysis. An extraction and analysis method was refined and tested for first Mercenaria mercenaria tissue, and then Coquina tissue spiked with standards. Naphthalenes, Phenanthrenes, and Chrysenes were used as representative components of total PAHs. Preliminary results from these tissues show a 100 fold increase over measured sand concentrations and a 1000 fold increase over measured water concentrations, making these tiny filter feeders sensitive indicators of PAH contamination. Spatial and temporal patterns of PAH body burdens and coincident sand and water PAH concentrations will be presented.

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USE OF THE VARIATIONAL ADJOINT METHOD IN ESTUARINE FINE SEDIMENT TRANSPORT MODELING

Bed erosion is one of the most important factors controlling the transport of sediment in estuaries, yet it is poorly understood for cohesive environments in general. Many fine-grained sediment transport models use the erosion rate parameter (M) to estimate fluxes to and from the seabed. Even though these models are quite sensitive to this parameter, it
cannot be reliably measured with current oceanographic instrumentation. A solution to this problem is to use the variational adjoint method. This robust data assimilation technique determines optimal parameter values by minimizing the difference between field observations and model estimates and allows for non-linear model formulations. In this study, the adjoint method was applied to a simple box model for depth-integrated suspended sediment concentration and Acoustic Doppler Velocimeter (ADV) data collected in 2007 from the York River estuary. Prior study results reveal POM behavior as a constant and varies based on particle type, as observed through settling velocities.

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IMPACT OF TROPICAL CYCLOONES ACROSS COASTAL REGIONS IN MEXICO

Tropical cyclones are weather systems that develop at low latitudes and over relatively warm oceans. While located within 500 km from the coast, they provide strong winds and heavy rainfall; however, the most damaging events are associated with intense cyclones that make landfall and impact coastal as well as inland ecosystems. We evaluate the effects on Mexican coastal ecosystems when they are distributed along more than 10,000 km of coastline in both the eastern Pacific and western Atlantic basins. Based on historical records from the National Hurricane Center (United States), we identify the spatial and temporal patterns of cyclone activity from the period 1970–2010 when more than one thousand named cyclones developed and over a hundred of them made landfall in Mexico. This information is used to determine landfall frequency and intensity, as well as spatial and temporal distribution along the Pacific, Gulf of Mexico, and the Caribbean region. Data from a national network of rain gauges is examined to evaluate precipitation accumulations around the landfall sites and identify significant rainfall anomalies. In addition, satellite imagery is used to document changes in the cloud (GOES) and vegetation (MODIS and Landsat) cover from case studies that resulted in significant impact on mangrove wetland structure and productivity; particularly, in areas where coastal lagoons are recognized as critical providers of ecological services that influence the development of regional economies.

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GEOGRAPHIC SEGREGATION OF THE CRYPTIC SPECIES COMPLEX Eurytemora affinis in the UPPER ST. LAWRENCE ESTUARY: HABITAT EXPLOITATION AND TROPHIC POSITION

Eurytemora affinis, a common calanoid copepod, is a cryptic species complex. Two genetically distinct clades occur geographically separated in the upper St. Lawrence estuary. The Atlantic clade (A) dominates the estuarine freshwater (< 0.5 PSU), whereas the North-Atlantic clade (NA) is distributed in the mesohaline part (0.5–20 PSU). Salinity appears to play a major role in the segregation, explaining the distribution of the NA clade. Despite a broad salinity tolerance of the A clade, its distribution is almost exclusive in oligohaline part. Therefore we suspect other environmental factors such as food availability and quality to play an important role in the distribution pattern. The aim of this study was to determine properties of each clade habitat, which might be responsible for geographic segregation of E. affinis clades. We provide evidence of different trophic position, hypothesizing that carbon stable isotope values of E. affinis may represent particulate organic matter (POM) stable isotope values of each habitat and that both clades will occupy the same trophic level. Our results revealed that POM carbon stable isotopes (δ13C) ratios did not differ between freshwater (~0.5 PSU) and brackish-water (0.5–20 PSU) habitats. However, there were significant differences in δ15N values between clades A and NA. The A clade showed more depleted values, representative of a food source characterized by freshwater and terrigenous origin, compared to more enriched values found in the NA clade, indicating a more marine origin. These results demonstrate decoupling between bulk POM and the two clades, suggesting food selection. Analysis of nitrogen stable isotopes (δ15N) positioned the NA clade on a higher trophic level than the A clade. Feeding of both clades probably differs either in number and composition of food sources or in the length of their respective food chain. Potential higher trophic level than the A clade. Feeding of both clades probably differ either in number and composition of food sources or in the length of their respective food chain. Potential

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FAULT-DRIVEN SEA LEVEL RISE, ACCRETION, AND LAND LOSS IN A BARRIER ISLAND SALT MARSH

Growth faults are a common geological feature in sedimentary and deltic basins around the world, and are often located adjacent to subsurface reservoirs of oil and natural gas. Extraction of these hydrocarbon resources may influence the subsidence that often occurs around these features, contributing significantly to local rates of relative sea level rise. At multiple locations along an active fault in Matagorda, Texas, our objective was to quantify the fault displacement, the local land accretion response, and the rate of wetland land loss. Recorded, vertical rates of displacement included 0.5 m over several decades, 0.2 m over a single year, and 0.13 m in single week. The spatial pattern of vertical movement over longer time scales as evidenced in shallow stratigraphy, and interpreted to result from both ongoing fault displacement and fault-propagation folding, exhibits a distinct sinuousal pattern distal to the fault plane. In general, the fault dropped on its downthrown side, yet rise in relative terms on its upthrown side. Wetland accretion rates were well correlated with fault movement over historical (~100 y) time scales. Land losses and plant species transitions were also strongly related to the quantity of vertical displacement at the decadal scale. Conversely, vertical fault movement was quite variable at year and weekly scales, going both upward and downward. Accretion rates at these time scales were not correlated with fault movement, but rather with plant cover type, hurricanes, and droughts. Based on plot-level data, vegetation and land loss appeared to be triggered by these short-term disturbances, yet were greatly magnified when also subjected to fault-induced sea level rise.

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PATTERNS OF GROWTH AND HERBIVORY IN MANGROVE FORESTS ALONG LATITUDINAL GRADIENTS IN THE ATLANTIC-CARIBBEAN EAST PACIFIC AND THE INDO-WEST PACIFIC: CONSEQUENCES OF NUTRIENT OVER-ENRICHMENT

Mangroves are an ecological assemblage of tropical and subtropical trees and shrubs adapted to grow in the intertidal. They provide the foundation for heterogeneous ecosystems with complex differences in forest structure, biodiversity, biogeochemistry, and hydrology that vary at tidal, latitudinal, and regional scales. Mangroves are threatened globally by climate change and nutrient over-enrichment. Our goal is to determine if nutrient loading interacts with climatic differences to alter growth, nutrient dynamics, and trophic structure. My collaborators and I have established a global network of long-term fertilization experiments (N = 19) that spans sites from warm temperate to tropical locations along the coasts of the two major biogeographic regions, the Atlantic-Caribbean East Pacific (ACEP) and Indo-West Pacific (IWP). We use latitude and tidal elevation as proxies for climate change and sea-level rise. Increased nutrients have significant effects on mangroves and their herbivores. Primary production is nutrient limited at all locations, but the nutrient limiting growth varies regionally and locally along tidal gradients. Nutrient enrichment alters patterns of herbivory in some but not all cases. Herbivory levels are comparable to values reported for other tropical forests. The fauna is generally characterized by endophytic specialists including miners, gallers, and borers. Latitudinal differences in herbivory emerge but are not the same for IWP vs. ACEP for all species or for all feeding guilds within a region. In the IWP, herbivory correlated significantly with latitudinal differences in temperature. In the ACEP, a trophic cascade based on the population dynamics of the mangrove tree crab controls patterns of canopy leaf damage.

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SIMULATING HYPOXIA ON THE TEXAS-LAUSIANA SHELF IN THE NORTHERN GULF OF MEXICO

The Texas-Louisiana shelf in the Northern Gulf of Mexico receives large inputs of nutrients and freshwater from the Mississippi/Atchafalaya River system. The nutrients stimulate high primary production is nutrient limited at all locations, but the nutrient limiting growth varies regionally and locally along tidal gradients. Nutrient enrichment alters patterns of herbivory in some but not all cases. Herbivory levels are comparable to values reported for other tropical forests. The fauna is generally characterized by endophytic specialists including miners, gallers, and borers. Latitudinal differences in herbivory emerge but are not the same for IWP vs. ACEP for all species or for all feeding guilds within a region. In the IWP, herbivory correlated significantly with latitudinal differences in temperature. In the ACEP, a trophic cascade based on the population dynamics of the mangrove tree crab controls patterns of canopy leaf damage.

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ECOLOGICAL PERIODIC TABLES: IN PRINCIPLE AND PRACTICE

The chemical periodic table, the Linnaean system of classification and the Hertzprung-Russell diagram are iconic information organizing structures in chemistry, biology and astronomy, respectively, because they are simple, exceptionally useful and they foster the expansion of scientific understanding and inquiry. Ecological periodic tables are information
organizing structures for ecology. Their foundational principles in the ecological tenet that the biologically-based chemical environment, that is, habitats, structure, and biotic communities. In practice, constructing ecological periodic tables begins with operationally defined habitat types. Quantitative field studies conducted on ecologically appropriate temporal and spatial scales for the biotic community of interest are then needed to determine their usage pattern across the habitat types. If the patterns are predictably recurring (periodic), the habitat types have been adequately defined for the epistemological purpose. If not, the original operational definitions of the habitat types were flawed or incomplete and further research is needed to parameterize them. Once periodic biotic patterns have been found, the habitat types and properties of the target biotic community, for example, its species richness, abundance and biomass, can be entered into tables rich in ecological and resource management-relevant information.

Eutrophication is discussed in the context of similar indices nationally and globally. While some metrics are common (e.g. chlorophyll, Secchi depth) are used to assess long-term relationships between policy/management, nitrogen loading, and eutrophication status. The index integrates 1) nutrient loading values for the watershed, 2) water quality, and 3) biotic integrity and response, with an emphasis on elcglass (Zostera marina) as a bioindicator. Index values are calculated seasonally and annually for three spatial segments delineated by geomorphology. Seasonal and annual nitrogen loading values are calculated based upon topography/hydrology, land use, water quality, precipitation, and atmospheric deposition. Biologically relevant thresholds of water quality metrics (total nitrogen, total phosphorus, dissolved oxygen, Secchi depth) are used to assess long-term (1989-2010) water quality monitoring datasets. Seasonal elcglass demographics (aboveground and belowground biomass, blade length, shoot density, and percent cover) from 2004-2006 and 2008-2010 comprise the biotic response. Brown tide bloom occurrence and benthic invertebrate density are also considered for inclusion in the index. This eutrophication index is discussed in the context of similar indices nationally and globally. While some metrics are common (e.g. chlorophyll, dissolved oxygen), there is little methodological consensus, confounding comparisons. Further, spatial and temporal data gaps are concluded to be a major challenge for eutrophication index development.

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ECOLOGICAL AND SOCIETAL IMPACTS OF NEW JERSEY LEGISLATION REGULATING FERTILIZER NITROGEN INPUTS TO BARNEGAT BAY - LITTLE EGGE HARBOR ESTUARY (NEW JERSEY)

Many communities, such as those surrounding Barneget Bay – Little Egg Harbor (New Jersey), face eutrophication problems. Eutrophication is the over-enrichment of water bodies with nutrients (often various types of nitrogen), leading to oxygen depletion, fish die-offs, and seagrass habitat loss. Nitrogen enters estuaries via many pathways and from a myriad of input sources, including runoff from lawn fertilizers. New Jersey recently passed Legislative Bills S-1411 and A-2290 to limit nitrogen loading from fertilizers by restricting fertilizer form, timing, and quantity applied (the three characteristics characterizing potential impacts), which is the management in the nation. Though difficult to distinguish from other nitrogen input sources, fertilizers have 'isotopic signatures' (subtle chemical differences) that can be used to map their influence in estuaries. Combining this chemical technique with the response trajectories of seagrass bioindicator populations and a baseline survey of community awareness, attitudes, and behaviors regarding fertilizer application can help us identify the potential ecological and societal impact the recent legislation has had towards reducing fertilizer inputs and mitigating eutrophication in Barneget Bay – Little Egg Harbor.

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CONSIDERATIONS FOR SUCCESSFUL IMAGE COLLECTION FOR SEAGRASS MAPPING

Submersed Aquatic Vegetation (SAV) typically occurs in shallow photic environments close to shore. This physical setting can be a challenging environment for many mapping technologies. For many years airborne optical remote sensing has provided good source data for SAV mapping. Nevertheless successfully collecting airborne imagery for SAV mapping is contingent on addressing several environmental variables. These include tidal stage, recent precipitation events, sea state, sun angle, atmospheric condition, and SAV phenology. In addition to environmental conditions there are important issues related to appropriate sensor settings and mission parameters that can influence the ability to successfully map SAV. These include spatial and spectral resolution, mission planning, spatial accuracy, and preprocessing. Recent advances in sensor design and web-based information have improved the ability to collect good SAV mapping imagery. Digital sensors allow multiple bands to be acquired simultaneously and with greater spatial accuracy than in the past. These data also better support semi-automated mapping processes. This presentation will cover some of the new tools available to improve mission planning, the new capabilities of the latest generation of digital cameras, and some of the new mapping methods which result in more quantitative and repeatable SAV mapping using examples from Humboldt Bay California, and the Continental Shelf of Texas.

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SUSTAINING ECOSYSTEM SERVICES IN A CHANGING CLIMATE - A JOB TOO BIG FOR SCIENCE?

Are we asking science to accomplish tasks beyond its ability? Sustaining ecosystem services in a changing climate must accommodate changes in political and economic climates as well. A decade of collaborative research and reflective coastal management in Gulf of Maine shorelines communities has produced and tested innovative models of collaborative action research. A variety of innovative strategies have been used to identify, value and communicate the importance of ecosystem services and to evaluate the consequences of management and policy choices on those services at a watershed scale. The Coastal Training Program of the Wells National Estuarine Research Reserve engages with scientists, planners, managers, government officials, NGOs and community groups whose shared missions are orienteering to sustaining ecosystems services. These working partnerships have been created and maintained to implement watershed protection, habitat restoration and land conservation projects. A collaborative research conceptual model has emerged as a result of this work. This model draws from well-established traditions of social science research but differs fundamentally from the positivist model used to conduct estuarine research that characterizes the biophysical structure, function and condition of estuaries and coasts. Principles and practices of community based ecosystem management and collaborative learning are used to integrate biophysical science research with policy, management and planning to sustain ecosystem services valued by society. The practicality of implementing this approach through the creation of communities of practice and an honest assessment of challenges will be critiqued as key elements of the evolving conceptual model. Attention to sense of place, mental models, opportunities for well facilitated dialogue and deliberation and realistic assessments of the kind of science required for decision making in collaborative research are part of this model.

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EUTROPHICATION INDEX DEVELOPMENT TO ASSESS BARNEGAT BAY- LITTLE EGGE HARBOR ESTUARY, NEW JERSEY

Recent legislation, impending regulations, and continuing management efforts are aimed at reducing nitrogen loading and associated eutrophication in estuaries nationally and globally. Previously, Barneget Bay –Little Egg Harbor (New Jersey, USA) and other coastal lagoons along the mid-Atlantic were characterized as ‘highly eutrophic,’ but spatial and temporal relationships between policy/management, nitrogen loading, and eutrophication status have not yet been established for this region. An index of eutrophication is developed for Barneget Bay-Little Egg Harbor as a component of an effort to quantify the status and trends of these relationships. The index integrates 1) nutrient loading values for the watershed, 2) water quality, and 3) biotic integrity and response, with an emphasis on elcglass (Zostera marina) as a bioindicator. Index values are calculated seasonally and annually for three spatial segments delineated by geomorphology. Seasonal and annual nitrogen loading values are calculated based upon topography/hydrology, land use, water quality, precipitation, and atmospheric deposition. Biologically relevant thresholds of water quality metrics (total nitrogen, total phosphorus, dissolved oxygen, Secchi depth) are used to assess long-term (1989-2010) water quality monitoring datasets. Seasonal elcglass demographics (aboveground and belowground biomass, blade length, shoot density, and percent cover) from 2004-2006 and 2008-2010 comprise the biotic response. Brown tide bloom occurrence and benthic invertebrate density are also considered for inclusion in the index. This eutrophication index is discussed in the context of similar indices nationally and globally. While some metrics are common (e.g. chlorophyll, dissolved oxygen), there is little methodological consensus, confounding comparisons. Further, spatial and temporal data gaps are concluded to be a major challenge for eutrophication index development.

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BENTHIC-PELAGIC COUPLING IN INNER SHELF ECOSYSTEMS NORTH AND SOUTH OF CAPE COD, MA

Tight benthic-pelagic coupling is a defining characteristic of shallow coastal marine ecosystems, but our understanding of the importance of this coupling on the continental shelf is limited by the small number of studies done in shelf sediments. We recently made the first measurements of organic matter consumption and nutrient regeneration across the sediment water interface for the inner continental shelf of Rhode Island across two annual cycles. We examined benthic-pelagic coupling in Block Island and Rhode Island Sounds, two inner-shelf systems that connect Narragansett Bay to the coastal ocean. Here, we make a comparison of benthic-pelagic coupling in Block Island and Rhode Island Sounds to similar measurements published by others for the inner-shelf sediments north of Cape Cod in Massachusetts Bay. Measurements of sediment oxygen demand show that the maximum rates of benthic metabolism in Block Island and Rhode Island Sounds are nearly double those published for stations throughout Massachusetts Bay.

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NAVIGATING THE HUMAN DIMENSIONS LANDSCAPE: PROVIDING ACCESS TO PRACTICAL SOCIAL SCIENCE INFORMATION THROUGH HD.GOV

Marine and coastal managers are routinely challenged with making complex decisions, influenced by the human dimensions of natural and cultural resource management. While managers recognize the utility of incorporating sound natural and social science information into their management decisions, they are often unfamiliar with the specific language and practice of applied social science and limited in their ability to employ its outputs to inform
their actions. HD.gov (HumanDimensions.gov) is an interagency Web portal developed to help aid manager and other decision makers in navigating the diverse landscape of social science data and human dimensions content available from natural resource management agencies, nongovernmental organizations, academia, and the private sector in a "one-stop-shop" format. The intent is to provide professionals working in a broad range of conservation and environmental management contexts, geographies, and ecosystems with a credible source for data, tools, methodology, policy, and qualitative materials, and degraded other information focused on the application of social science to natural and cultural resource management problems. The portal employs a Wiki style format that provides a dynamic link between (1) producers – social science practitioners who ply their craft in the context of natural and cultural heritage stewardship; and (2) consumers – managers and decision makers who need to learn about or utilize human dimensions information, tools, and methods to inform their work. As HD.gov continues to grow and evolve, it strives to serve as an open community of practice for human dimensions professionals and interested parties in the U.S. and around the world. This presentation will provide an overview of HD.gov and afford participants the opportunity to ask questions, offer suggestions, and explore ways to become involved in the effort.

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MODEL ANALYSIS OF EUTROPHICATION CONSTRAINTS ON AN EVERGLADES RESTORATION PROJECT
The Comprehensive Everglades Restoration Plan involves a large number of projects whose net result will lead to increased water flows to the freshwater and estuarine systems of the greater Everglades system. The Decompartmentalization Project is central to the overall restoration plan, with a goal to increase water flows and restore the hydro-ecology of system. However, with increased water flow volumes into marshes, phytoplankton (P) loads to the ecosystems can increase, potentially posing constraints on the allowable inflows to the oligotrophic Everglades. For the first phase of this Project, a multi-agency team is using a validated ecological landscape model (http://ecolandmod.fas.ufl.edu) to evaluate the trade-offs between the benefits of increased water flows vs. P loading constraints. Analyses of the relative benefits among simulated restoration alternatives are being considered within the context of eutrophication impacts, which are generally more localized relative to the broader-scale hydrologic effects of the changes in management infrastructure and operations.

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EUTROPHICATION AND ITS EFFECT ON SEAGRASSES IN ST. ANDREW BAY, FLORIDA: SEAGRASS PRODUCTIVITY, EPIPHYTE GROWTH RATES, AND STABLE ISOTOPE INDICATORS
Long-term trends in water quality data collected monthly since 1990 from over 70 stations in the St. Andrew Bay system, Florida, were used with seagrass and epiphyte productivity data collected at 18 permanent monitoring sites in West Bay and St. Andrew Bay. The St. Andrew Bay system covers approximately 277 square kilometers and is composed of four smaller bays: West Bay, North Bay, St. Andrew Bay, and East Bay. Although seagrass cover in North Bay, St. Andrew Bay, and East Bay has not changed much since 1953, approximately half of the seagrasses in West Bay have been destroyed or degraded since then. Comparisons among these bays show higher turbidity, higher chlorophyll a, total nitrogen and total phosphorus concentrations, and higher light attenuation in West Bay. These water quality conditions result in shallower seagrass depths, higher epiphyte growth rates, and narrower Thalassia leaves that are also depleted in 13-C. We propose that the 13-C content of the seagrass leaves be used as an indicator of eutrophication along with more traditional measures: seagrass depth, epiphyte growth, and water quality.

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OSTERM RESTORATION - FEASIBILITY AND WATER QUALITY BENEFITS IN A HIGHLY URBANIZED BAY
Jamaica Bay, New York is a highly eutrophic tidal embayment that receives wastewater from four municipal wastewater treatment facilities. The Bay has also been highly altered by man’s activities, including dredging for navigation and airport construction and hardening of shoreline. In order to improve water quality within the bay, resource managers are considering Implementation of top-down controls, i.e., establishment of oyster reefs, as well as traditional bottom-up controls, i.e., nutrient reduction. Residence time within the Bay is fairly short, so placement of the oyster reefs within the bay to maximize residence time for larval recruitment to provide a sustainable oyster community is an important consideration. However, in general, potential areas with the longest residence time also have degraded water quality (low dissolved oxygen), which can be a stressor on larval survival. This paper will discuss strategies to maximize larval survival and recruitment within the bay using a linked hydrodynamic – particle tracking model, the latter of which includes oyster larvae biological behavior. We will also describe potential water quality benefits that may be achieved with the implementation of oyster reefs based on a linked hydrodynamic – water quality – suspension feeder model of the Bay.

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HABITAT USE OF GRAY SNAPPER (LUTJANUS GRISIEUS) IN SEVERAL FLORIDA ESTUARIES
Gray snapper, Lutjanus griseus, use a variety of habitats through their ontogeny. Juveniles occupy estuarine nursery areas, such as seagrass beds or mangrove shorelines, while adults are more commonly found in deep channels or in offshore water associated with hard bottom habitats. Habitat suitability analyses were conducted for juvenile (< 100 mm SL) and subadult (≥ 100 mm SL) gray snapper collected from 1996 to 2009 during fisheries-independent monitoring in six estuarine systems along the Gulf and Atlantic coasts of Florida. This time series, encompassing up to fourteen years of data depending on the estuary, was used to determine size-specific relationships between abundance, habitat, and environmental conditions. Temperature, salinity, and SAV percent cover influenced the distribution and relative abundance of gray snapper. Clear patterns of resource use and selection were generally consistent across estuarine systems; both size classes of gray snapper selected sites with warm temperatures (26 - 34 °C), high salinities, and greater than 50 % SAV cover. Juvenile gray snapper, however, tended to occupy shallower sites than subadults. In several estuaries, gray snapper were most abundant at sampling sites with overhanging vegetation along the shoreline and a high percentage of SAV, so separating out the importance of shoreline versus benthic habitat in these cases proved to be difficult. By examining long-term data collected in multiple estuarine systems at sites with differing habitat types and environmental conditions, this study builds upon previous work by characterizing patterns of habitat selection by gray snapper across a latitudinal gradient in flora and climate.

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SEBASTIAN INLET STATE PARK NEARSHORE WAVES, CURRENTS AND TEMPERATURE
Florida Institute of Technology current meters have been deployed since 1996 offshore of Sebastian Inlet State Park, Florida, to collect directional current velocity profiles, directional wave data, and water temperature data since 2004, encompassing up to fourteen years of data depending on the inlet management decisions. The instruments are attached to moored structures by scientific dier operations. A water level sonde has been deployed at the Inlet’s north jetty, providing surface temperatures and referenced water levels real-time. During the 2004 and 2005 hurricane seasons, three major hurricanes crossed Florida 55 km south of this instrumentation. Average current speeds at this site are 0.2 m s-1 and are directed shore parallel to the south. Current speeds reached 2 m s-1 for Hurricane Frances and 1.5 m s-1 for Hurricanes Jeanne and Wilma; flow was directed southward pre-eye and northward post-eye during Frances and Jeanne and opposite for Wilma. The surface current speeds during the hurricanes were found to be from 3 to 20% of the wind speed. The significant wave heights during each hurricane reached 4 m. The computed storm surge levels for Frances and Jeanne were highest north of the eye, 36 km south of Sebastian Inlet. This sea surface slope would have produced a northward pressure gradient driven flow, contributing to the current speeds that were 2.5 times faster post-eye passing than pre-eye passing. Summer water temperatures of 25°C have been observed to decrease by up to 15°C due to upwelling. These data provide an increased understanding of the current and wave conditions in the nearshore water column during the landfall of severe storms on the east coast of Florida. The upwelling data will be coupled with a larger continental shelf instrument array to track the cold water masses from the shelf break to the inner shelf.
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RELATIONSHIPS OF FRESHWATER INFLOW WITH THE LOCATION OF THE CHLOROPHYLL A MAXIMUM AND SEASONAL PHYTOPLANKTON POPULATIONS IN THREE TIDAL RIVERS IN SOUTHWEST FLORIDA

The response of the location of the chlorophyll a maximum to reductions in freshwater inflow is used as a management tool to develop water supply withdrawal schedules for tidel river estuaries in Southwest Florida. In three comparable tidal river systems, the location of the chlorophyll a maximum typically moves between 5 and 16 kilometers due to seasonal changes in freshwater inflow. Regressions to predict the location of the chlorophyll a maximum show that it generally migrates about 0.5 to 0.8 kilometers upstream in each river due to freshwater withdrawals that are permitted from these systems. The interaction of the each river’s geomorphological characteristics with the volume of freshwater inflow affect where the maximum chlorophyll a concentration occurs on the salinity gradient. Maximum chlorophyll a concentrations typically occur in mesohaline waters in the Alafia and Peace Rivers, but occur in tidal freshwater and oligohaline waters in the Little Manatee River due to the effect of a large braided zone that slows water transit times in the upstream tidal reaches. Hydrodynamic models have been used to simulate estuarine residence time in each system and water ages at various locations in each river as a function of freshwater inflow. When water ages exceed 1.5 days, large phytoplankton blooms can occur within different sections of the Alafia River. Total phytoplankton cell counts and chlorophyll a concentrations are frequently an order of magnitude greater in the Alafia due to very high nutrient loading rates, but chlorophyll a concentrations remain comparatively low in the river’s non-tidal reaches due to shading by the canopy and short water transit times. Cyanobacteria populations are often greatest in the tidal fresh and oligohaline waters in the Peace River due to blooms that occur in the freshwater portions of that river, which is broader with greater exposure to solar radiation than the narrower Alafia and Little Manatee Rivers.

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COMPARING SEAFLOOR GEOLOGY AND BIOLOGY IN MASSACHUSETTS

Since 2005, the Commonwealth of Massachusetts and the USGS have collected interferometric sonar, grab, and video data to map seafloor geology. The need for a better understanding of the links between the geologic mapping and biological (habitat) mapping were recently prioritized under the Science Framework in the Massachusetts Ocean Plan. Dedicated multi-agency research efforts were conducted in June 2010 and September 2011 on the EPA survey vessel Bold in order to determine how well the geologic maps predict substrate and infauna. The area of study included Massachusetts territorial waters that were previously imaged by the USGS with interferometric sonar methods. Sample locations were selected using an optimal sampling strategy to examine the seafloor community types associated with the USGS analysis of geophysical regions. At 400 stations, video and grab samples were analyzed for grain size and infaunal community. Results were mixed, with some USGS physiographic zones describing substrate and infauna well, and others were more variable and not predictive of substrate and infauna. The data was also characterized using CMECS. This presentation will focus on the results of these analyses, including the applicability of CMECS to our classification needs. Lastly, how this information is incorporated into the Ocean Plan will be described.

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TOP PREDATORS AND PRODUCTIVITY GRADIENTS AFFECT HERBIVORY AND PLANT ARCHITECTURE IN MANGROVE FORESTS

Top-down effects of predators and bottom-up effects of inorganic nutrients are important determinants of community structure and ecosystem function in many aquatic and terrestrial habitats. While nutrient availability is known to affect productivity and species interactions in mangrove forests, the ecological significance of predators in these threatened systems is still poorly understood. To address this gap, we investigated the relative and interactive effects of predators and abiotic factors on plants and arthropods by excluding vertebrate top predators (birds) from Rhizophora mangle (red mangrove) canopies across natural productivity gradients caused by nutrient-limitation. We constructed 1m^2 PVC frames around entire small, slow-growing trees (situuated in highly nutrient-limited, relatively unproductive areas) and around individual branches of comparable size from large, fast-growing trees (situuated in less nutrient-limited productive areas) on two islands off the coast of Belize. Half of these frames (N=20) were covered with propylene netting to exclude birds, while the others served as controls. Data on arthropod presence, herbivory and branch growth were collected periodically over 16 months. Arthropods were more abundant and herbivore damage inflicted on leaves and buds was greater in the absence of birds and in more productive areas. Effect sizes were greater for bottom-up compared to top-down factors and interactive effects were not strongly supported. While birds did not affect branch elongation or leaf production, they did significantly alter the architectural complexity of branches. Branch architecture was less complex (fewer segments per total length) in the absence of birds, and also less complex in more productive areas. Birds likely affected the architecture of mangrove trees indirectly by reducing herbivory on apical meristems from which new branch segments are usually produced.

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HABITAT MAPPING OF CONCH REEF, FLORIDA, FL: HIGH-DENSITY, HIGH-RESOLUTION GEODACOUS AND BENTHIC PHOTOGRAPHIC MAPPING FROM AN AUV DURING A PRECURSOR MISSION TO NEEMO XV

In early May 2011, a 4-day survey was conducted at Conch Reef, FL surrounding the Aquarius Underwater habitat. The platform for these surveys was a Gavia autonomous underwater vehicle (AUV) equipped with phase measuring swath bathymetry, side-scan sonar, color still camera, and a HD video camera. Water quality parameters (i.e., salinity, temperature, and dissolved oxygen) were concurrently measured. Although these surveys were developed as part of a precursor mission in support of the NEEMO (NASA Extreme Environment Mission Operations) XV program, they also provide an unprecedented level of reef habitat detail critical for coral reef monitoring and management throughout the Florida Keys Marine Sanctuary. A previous NOAA multibeam survey in 2007 provided baseline coverage (1.5 km x 45 km), but had a hole in the Carpenter Basin around the Aquarius Habitat, due to the challenges of surveying from a large vessel with significant underwater obstacles present. Our new survey succeeded in collecting data around the habitat in the previously unmapped region. The collected data provides 0.5 m resolution bathymetry in the Carpenter Basin and then 1.0 m resolution in the rest of the survey area (2 km x 0.8 km). The collected geodacous data is being analyzed with a statistical segmentation program (QTC SwathView) for classification of the seabed into distinct acoustic bottom types, which will be ground-truthed by the collocated benthic images. Photographic images were collected with an internally mounted camera, and HD video was collected with an external camera. Initial data processing of these photo mosaics indicates they should be able to provide significant information on the invertebrate fauna of the reef, their vertical structure and habitat utilization by fish. In the near term, these data will be utilized by mission planners for NEEMO XV, but in the long term these data will be used to plan future space analogue studies and to assess the health of the reef.
INVESTIGATIONS OF THE EFFECTS OF OYSTER MORPHOLOGY ON PARTICLE CAPTURE USING A HYBRID ECOSYSTEM INDIVIDUAL-BASED MODEL.

The Potomac River estuary is susceptible to changes in water quality, affected by watershed land use, population, and climate that affect sediment, nutrient, and freshwater inputs to the receiving water. Feedbacks between a decline in water quality and the Eastern oyster are of interest to current efforts to restore the oyster population and meet Total Maximum Daily Load regulatory requirements. Existing models describe the bioenergetics of oyster growth in the simulation environment of a complex hydrodynamic water quality model. Here we explore implications of parameterizing oysters using model units of individuals rather than grams carbon of oyster per square meter. By modeling individual oysters, we can introduce new formulations that explore the relationships among oyster size, morphology, and emergent oyster reef structural characteristics on particle trapping and growth dynamics, creating a dynamic food supply variable that is a function of both individual characteristics and the environmental context of the oyster reef. In this case, filtration rate becomes a function of gape area, or opening size of the oysters, and the particulate organic carbon becomes a function of oyster orientation in relation flow and location on a reef. We present this new model and a comparison of simulated oyster dynamics.

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MAPPING THE SPATIAL AND TEMPORAL ABUNDANCE OF SEASONAL DRIFT MACROALGAE IN THE INDIAN RIVER LAGOON, FL

Drainage of the St. Johns River marshlands, commercial and residential development, and numerous other hydrological alterations have subjected the estuarine Indian River Lagoon to pulses of freshwater and nutrient-rich runoff. As a result the frequency and magnitude of seasonal drift macroalgae (DMA) blooms have increased. This study presents methodological advances developed over the course of three acoustic surveys of Indian and Banana Rivers using a single-beam dual-frequency acoustic ground discrimination system. The objectives were to quantify the abundance and distribution of DMA as part of a 1996 initiative launched by the St. Johns River Water Management District to reclaim historical seagrass ranges. Novel post-processing methods were developed to refine 200+ acoustic training samples into pure end-member classes of bare substrate, submerged aquatic vegetation, and DMA, which allowed for direct and accurate computation of DMA cover and biomass. Between-survey comparisons revealed recurrent patterns of DMA deposition. Within-survey time-series studies revealed the life history of DMA patches. The same acoustic data were also used to quantify the horizontal and vertical extent of muck deposits. These easily re-suspended, anoxic and nutrient-laden deposits threaten seagrass beds and local biodiversity; knowledge of their location and extent are essential for guiding removal efforts. The incorporation of dual-frequency digital transducers with new post-processing techniques established an accurate, efficient, and temporally consistent method for acoustically mapping DMA biomass, with ancillary output at minimal additional acquisition costs.

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EFFECTS OF LOW OXYGEN ON SEDIMENT NITROUS OXIDE FLUX IN A SHALLOW, COASTAL ECOSYSTEM

Despite the importance of nitrous oxide (N₂O) as a driver of global climate change and stratospheric ozone depletion, the environmental factors controlling its flux in aquatic ecosystems are largely unknown. Aquatic production of N₂O accounts for approximately one third of total global emissions and over 90% of emissions from rivers, estuaries, and continental shelves are considered anthropogenic. This has been attributed to nitrogen (N) inputs from fertilizer use, wastewater runoff, and atmospheric deposition. Although the correlation between N loading and N₂O production appears to make coastal ecosystems areas of potentially high N₂O emissions, the effect of altered environmental conditions on this flux are not clear. Waquoit Bay is a shallow, coastal estuary on Cape Cod that receives high loads of N from its densely populated watershed and frequently experiences conditions of hypoxia and anoxia in the summer. This site presents an ideal location for investigating the factors regulating the production/consumption of N₂O by nitrification and denitrification. Measurements from both field observations and experimental manipulations explore the importance of both the frequency and duration of low oxygen conditions on the flux of N₂O. Preliminary sediment flux rates from July and September 2010 ranged from -172 to 25 nmol N₂O-N m⁻²hr⁻¹ indicating that Waquoit Bay sediments can be a source or sink of N₂O.

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PREDICTING HURRICANES OF THE FUTURE?

Global climate is warming, and as a result, the temperature of the tropical Atlantic Ocean has been rising for the last 100 years. Since warm water provides the energy to drive the formation and growth of hurricanes, it is reasonable to expect that continued climate change may have an influence on the number and strength of hurricanes in the Atlantic Ocean. Such an effect could change the impacts that coastal communities in Florida will experience in the future. But, the detection of change in the number and strength of Atlantic hurricanes over the last 100 years is difficult because of the natural large variability in yearly storm numbers and strength - and therefore it is difficult to say with certainty that the rising levels of CO₂ in the atmosphere caused by man have led to any changes in hurricanes to date. However, models based on theory largely agree that increased increases in CO₂ in the atmosphere, and therefore continued warming of the atmosphere and the sea surface temperatures, are likely to lead to fewer overall hurricanes, but an increase in the average strength of hurricanes by 2 to 11%, and an increase in the frequency of major hurricanes. Predicting whether these hypothesized future storms will impact coastal communities in Florida is more difficult still, as we currently have an imperfect ability to predict the paths of already-formed storms.

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HEAVY METALS IN THE BENTHIC FOOD CHAIN OF THE EASTERN CHUKCHI SEA

The eastern Chukchi Sea, Alaskan Arctic, is a unique shallow sea with a highly productive bentthic ecosystem that has been subjected to limited human activity. We have determined concentrations of several heavy metals as well as stable carbon and nitrogen isotopes in suspended matter, bottom sediments, plankton, amphipods, isopods, bivalves, gastropods, crabs and benthic fish. Data for dissolved metals also are available. A conceptual model that considers trophic level, individual size, habitat, food source and geographic distribution is used to describe concentrations of heavy metals in biota. The Chukchi Sea is ideally suited as a model benthic food chain that is in transition due to global climate change. Concentrations of total mercury (THg) and methylmercury (MeHg) were highest at upper trophic levels (b/15N=15). Average values for THg in muscle tissue from Bering flounder and Arctic cod were 56 and 130 ng/g (dry wt), respectively. Concentrations of THg and MeHg were variable for individual species (RSD 20-80%) as a function of size, food source and location; however, average MeHg/THg ratios were quite uniform for a given species (RSD ~15%). Furthermore, the MeHg/THg ratio increased predictably with increasing trophic level from <0.1 in plankton to >0.85 in the top predators, gastropods, crabs and fish. Average concentrations of Zn showed a large range among species (20-217 μg/g); however, Zn is highly regulated such that RSD values for individual species were <15%. No relationship between Zn concentrations and trophic level (b/15N) was observed. Concentrations of As were predictably high (>100 μg/g) in gastropods and >15 μg/g only in organisms from upper trophic levels. Results also are available for Cd, Cu, Fe, Mn and Pb. The observed trends emphasis the varying importance of size, food source, trophic level and geographic distribution to explain the complex patterns for heavy metals in the benthic food chain of the eastern Chukchi Sea.

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DEVELOPING WETLANDS CORRECTION FACTORS FOR A LIDAR-DERIVED "BARE EARTH" DIGITAL ELEVATION MODEL IN NORTHEASTERN FLORIDA

For many studies an accurate representation of the Earth’s surface elevation is essential. LiDAR (Light Detection And Ranging), an optical remote sensing technology that measures properties of scattered light to determine elevation, is a remote sensing technology used to obtain data to develop digital elevation models (DEMs). DEMs used in environmental studies are typically characterized as “bare earth” indicating that the final elevation data does not include vegetation. LiDAR ground control checkpoints for determining vertical accuracy are routinely located in areas of open terrain where the laser pulse consistently reaches the Earth’s surface. In the final DEM product wetland areas may be classed as “Low Confidence Areas” indicating that adequate vertical data cannot be clearly determined to accurately

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define the DEM. Therefore, the vertical data may not meet the project’s overall data accuracy requirements in these areas due to the high vegetation. Field surveyed elevation data in wetland areas from 27 transects (St Johns River Water Management District Minimum Flows and Levels or MFL program, in northeastern Florida) was compared to elevation from three LiDAR derived “bare earth” DEMs, produced in 2006, 2009 and 2010, comparing over 5,800 datapoint pairs. The DEM elevation data matched the field survey data well in upland areas but showed a consistent positive bias in wetland areas, representing a variety of vegetation types for all the DEMs. A corrected DEM was prepared for a portion of the St Johns River basin (an area containing 4 MFL transects, 1,485 datapoint pairs) providing a better representation of the bare earth based on comparison to the surveyed elevation data. The correction method was validated using an independent elevation dataset (155 datapoint pairs) and an overall median error of zero was achieved. The consequences of using an uncorrected DEM, especially important in studies involving sea level rise, will be demonstrated.

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THE EFFECTS OF WARMER TEMPERATURES ON SPARTINA ALTERNIFLORA AND SALT MARSH SEDIMENT CHARACTERISTICS

Salt marshes are critical coastal ecosystems threatened by global atmospheric changes, including sea level rise and warming. To assess impacts of warming on salt marshes, we examined some short-term and long-term effects of increased temperature on salt marsh cordgrass, Spartina alterniflora and bottom ground biomass. We used clear plastic enclosures to raise the temperature of the salt marsh canopy, and measured responses of S. alterniflora and sediment characteristics. Temperatures in enclosure treatments were approximately 7°C above those temperatures measured in control treatments and the adjacent marsh, a reasonable increase in temperature forecasted for the coming decades. Rates of photosynthesis of S. alterniflora did not show a clear pattern of responses to higher temperatures over the short-term from hours to days, nor over weeks in the longer-term. Although evapotranspiration was variable, rates tended to be higher in treatments exposed to higher temperatures. There were clear responses below ground in the sediment porewaters. Porewater salinities decreased with increasing air temperature. This response occurred over short time scales of hours. The freshening of porewaters in enclosures with higher air temperatures were most likely the result of a combination of changes in aboveground factors, including photosynthetically active radiation, photosynthesis, evapotranspiration, and increased air temperature. The results of this study elucidate how sea level rise and warming may work synergistically or antagonistically to threaten salt marsh habitats. For example, fresher porewaters under warmer air temperature regimes may increase S. alterniflora’s tidal inundation tolerance or may increase suitable habitat area for more competitive species, such as the highly invasive Phragmites australis. Understanding the nature of this interaction is essential to preserving salt marsh function and mitigating salt marsh losses.

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BIO-ENERGETIC MODEL OF AN OYSTER REEF USED TO DELINEATE THE PROVISION OF ECOSYSTEM SERVICES

Oyster reefs are complex biological systems critical to the provision of ecosystem services such as food, raw materials, habitat for recreationally and commercially important species, water filtration, and nitrogen removal. Water filtration and removal of nitrogen by the oysters from the system is intricately linked in that nitrogen is removed by filtration of water, ingestion of phytoplankton, and assimilation into oyster tissue. This assimilation of nutrients such as food, raw materials, habitat for recreationally and commercially important species, such as Phragmites australis. Understanding the nature of this interaction is essential to preserving salt marsh function and mitigating salt marsh losses. This type of model, although it does not entirely capture the complexity of the oyster reef system, is useful in comparing some of the benefits humans receive from associated natural, biological processes. Simplification of the model to include only drivers of ecosystem service provision creates a user-friendly management tool that effectively communicates benefits to humans provided by the oyster reef. Use of local environmental parameters allowed scaling of the model to a level at which local decisions are typically made, reducing need for resources beyond those existing in local, regional and non-governmental policy-making organizations.
tolerant to nutrient enrichment, which can be a key element for benthic indicator development.

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THE ALGAL VEGETATION IN THE OUTER PART OF ISFJORDEN, SPITSBERGEN: A REVISIT OF PER SVENDSENS SITES AFTER 50 YEARS

The benthic algal vegetation has been investigated at two different sites in the outer part of Isfjorden, Svalbard, during 27 – 29 July 2007. One exposed site at Kapp Linné and one sheltered site in Ymerbukta were sampled both in the littoral and in the sublittoral zone. A total of 83 different taxa were recorded, 81 from the sublittoral and 40 from the littoral zone. The sublittoral did not differ much but the number of species in the littoral differed between the two sites; Kapp Linné had 39 while only 5 species were found in Ymerbukta. The results are compared to a survey made by Per Svendsen in 1954 and 1955 in order to seek any changes in the diversity. Even though the number of species is difficult to compare directly, we registered higher species number than Svendsen did 50 years ago – 83 compared to 59. The most possible explanation for this change lies in the precision in identification of the smaller species. The difference seemed more pronounced in the littoral zone than in the sublittoral. A reduced ice scouring due to less ice in the Svalbard area during the last decades supports these findings.

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ACCELERATING THE MYRTLE GROVE DELTA BUILDING PROJECT

The Mississippi River Delta is experiencing high rates of coastal land loss due to a wide variety of both natural and anthropogenic causes. During the 20th century Louisiana lost approximately 5000 square kilometers of land, and impacts on communities, fisheries, infrastructure, wildlife, and the environment are considerable with increasing land loss. Restoring natural deltoid land building processes is one of the pressing concerns to increase resiliency of this ecosystem vulnerable to sea level rise. Congress authorized large-scale coastal Louisiana restoration and provided strong directives in passing the 2007 Water Resources Development Act. A coalition of national and local environmental groups have formed a unique partnership with Louisiana’s Office of Coastal Protection and Restoration to catalyze action in the development and implementation of a delta restoration project in Louisiana, the Myrtle Grove Division. Our coalition is participating in and helping support a comprehensive modeling approach to maximize sediment efficiency of a modified Myrtle Grove diversion. The effort includes extensive sediment and hydrodynamic data collection, numerical and physical modeling of the river and receiving basin, diversion structure design, quantification of the land building capacity, and assessment of both positive and negative river-side and bay-side impacts. Also addressed are several key uncertainties pertinent to diversion restoration projects including sediment availability, the dispersal and retention of sediments from diversions, induced sedimentation, and the effectiveness of pulsing. An expansive stakeholder outreach effort is underway to communicate the science and build state and national support. Our coalition is also fostering coordination of policy, science, funding, authorization, and community outreach to accelerate implementation of this and other large-scale Mississippi River Delta restoration projects.

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QUANTIFYING LAND USE CHANGE AND DRIVERS FOR THE LOWER PASCAGOULA RIVER BASIN

Coastal wetlands provide an array of ecosystem services including carbon sequestration, water quality improvement, and coastal storm protection. They are, however, changing at unprecedented rates with the displacement of freshwater vegetation by more salinity-tolerant communities and massive loss resulting in conversion to open water (Reyes et al., 2000 and 2004) due to anthropogenically-driven land-use change, relative sea-level rise from subsidence and climate change (Shirley and Battaglia, 2006), and coastal storm impacts (Ramsey and Lane, 1997). The Delineation of wetlands is important since it provides the necessary details for wetland delineation. Our results show that there has been a continuous loss of estuarine emergent wetlands to urban, agriculture and open water over the past 35 years. We used the IDRISI Land Change Modeler to identify potential drivers for the wetland change and to predict the wetland change for the next 35 years based on those drivers and the past land change patterns.

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TIDAL FLAT MORPHODYNAMICS: A SYNTHESIS

Tidal flats are well suited for morphodynamic study in that characteristics such as profile shape, bed slope and grain size systematically vary as a function of sediment supply and wave and tidal forcing, and wave- and tide-induced velocities across flats are, in turn, a direct function of flat morphology itself. On most tidal flats, spatial asymmetries in hydrodynamic energy associated with tides and waves drive sediment landward and seaward, respectively. Assuming morphological equilibrium is associated with the minimization of spatial asymmetries in energy, dominance of by tides results in a convex-upward flat profile, whereas dominance by waves results in a concave-upward profile. These extremes lead to analytical solutions for flat width, slope and degree of curvature as a function of tidal range, wave height and the critical velocity for profile stability. Although a tide- or wave-dominated static equilibrium theoretically exists at each of these extremes, natural tidal flats over annual time-scales are better approximated by a dynamic equilibrium somewhere between these two asymptotes. Observations and models indicate that within this range of morphologies, convex-upward profiles are further favored by increased sediment supply, and increased bioaggregation/adhesion; concave-upward profiles are further favored by decreased sediment supply, and increased bioturbation. Processes/properties associated with evolution towards a convex (vs. concave) profile include shoeward (vs. seaward) sediment transport, net deposition (vs. erosion), decreased (vs. increased) grain size, and a form that promotes seaward (vs. retreating landward). Because surficial grain size responds to energy gradients much more quickly than overall morphology can adjust, the common presence of tides without strong waves (alternating with much shorter periods of intense waves) leads tolandward direction of surficial grain size most of the time.

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JELLYFISH AND CHIPS: THE NEXT “IT’S WHAT’S FOR DINNER”? IN FLORIDA?

Increased sightings of jellyfish along Florida’s east coast has led to concerns about our waters and beaches, including: 1) Why are there so many jellyfish here?; 2) Will this happen again or get worse?; and 3) What can we do? Definitive answers are not available, in part due to a lack of historical data on numbers and distribution of jellyfish off Florida’s east coast. However, knowledge of jellyfish biology, recent conditions off our coast, and large-scale environmental changes can yield insights and guidance. In particular, the Cannonball jellyfish (Stomolophus meleagris), Mauve Stinger jellyfish (Peleia noctiluca), and Portuguese Man-of-War siphonophore (Physalia physalioid) illustrate key reproductive differences and hazards to beachgoers and tourism. Jellyfish lack bones, have bodies that are >95% water, tolerate a wide range of environmental conditions, and are not appetizing to most predators. Some jellyfish not only reproduce sexually, but they also do so asexually, which means they “clone” large numbers of offspring when conditions are favorable. Jellyfish are weak swimmers, thus their distributions are determined primarily by currents and winds. Information on currents and sea surface temperatures suggest aggregation and increased reproduction as potential drivers of recent events. In contrast to these proximate influences, ultimate drivers determine if events will recur or worsen. Drivers promoting large numbers of jellyfish include increased availability of structural and debris that serves as habitat for benthic stages capable of asexual reproduction, long-term warming of surface waters that promote growth and reproduction, overfishing that reduces potential competitors for food, and increased supplies of nutrients that ultimately provide more food. Given these tentative answers, community leaders should consider partnering with State agencies to use existing surveillance as an early warning system and support research that can foster a predictive model.

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NBI GULF COAST FISHERIES MAPPING APPLICATION: MAKING COASTAL FISHERIES DATA AND TREND ANALYSES AVAILABLE TO A WIDE AUDIENCE

Fish and wildlife resources provide some of the Gulf Coast’s greatest economic, recreational and aesthetic assets. Each state wildlife management agency along the Gulf Coast takes part in coastal fisheries management, but with limited inter-agency collaboration, different sampling and reporting methods are often used. The goal of the NBI Gulf Coast Fisheries Mapping Project is to combine these records into a consistent, understandable, user-friendly format that gives a comprehensive view of the state of Gulf coastal fisheries. With
many stresses being placed on coastal fisheries, it is important to monitor them to determine whether populations are increasing or decreasing and whether management actions may be necessary. The data provided by the Texas Parks and Wildlife Department (TPWD) and the Louisiana Department of Wildlife and Fisheries (LDWF) includes information on coastal species sampled using various gear types such as a bag seine, shrimp trawl, gill net, and oyster dredge. Data from each sample include species identification, catch numbers, lengths of specimens captured, biological data (temperature, dissolved oxygen, salinity), gear type, location, date and time, weather conditions, and other characteristics of the sampling event. Over thirty years of data from the TPWD and LDWF were analyzed to determine seasonal and yearly trends in relative abundance for key estuarine fisheries. This discussion will focus on presenting the results of the trend analysis, including spatially and temporally significant results. In addition to trend analysis, the mapping application allows users to view physico-chemical data such as average salinity, dissolved oxygen, turbidity, and water temperatures for the eight major bay systems in Texas and seven coastal study areas in Louisiana. The NBII data portal also includes an option to download the relative abundance data, hydrological data and supporting metadata.

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THE USE OF MICROCHEMICAL VARIATION IN BIOGENIC MINERALS TO TRACK CHANGING AQUATIC ENVIRONMENTS REQUIRES UNDERSTANDING OF NUCLEATION AND GROWTH IN UNUSUAL MEDIA

The rapidly expanding study of the microchemistry of biomineralization in fish (e.g. otoliths (CaCO3) and vertebral and statoliths (Ca5(PO4)3(OH)) utilizes analytical approaches and techniques that originated in the mineral sciences. These studies are used to determine the natal origins of larval fish, migration patterns, stock structure, etc. given that fish can experience chemically distinct environments during their different life stages and that evidence of these changes may be permanently preserved in the biomineralization. Fresh water and near shore fish are potentially exposed to more distinct chemical environments than open marine species and therefore the possibility exists to use unique chemical signatures in the study of such aquatic systems. Modern analytical capabilities permit the measurement of elemental and isotopic chemistry of these biomineralized structures, at a spatial (down to 5-10 micrometers), temporal, scale that allows high resolution monitoring of the life histories of fish. Otoliths and other biominerals nucleate and begin growing during the earliest stages of larval fish development and prior to significant interaction of the larva with the ambient environment. Otolith chemical changes that relate to changes in the ambient aquatic environment must be separated from those produced through ontogeny. There are also complex and multiple chemical equilibria involved between the aquatic environment and the site of, and processes involved in, biomineralization. Recent studies focusing on aspects of the mechanisms of element partitioning between the environment and growing biominerals and the time required for a fish to equilibrate with an environmental change will be explored. Different models of element uptake in biominerals are required for different fish species living in the same environment.

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SEDIMENT DYNAMICS IN A SHALLOW SUBTROPICAL LAGOON

Estero Bay is a shallow subtropical lagoon fronted by barrier islands in Southwest Florida, USA. Low wave energy and low tidal energy result in generally low suspended sediments. However, strong diurnal peaks in turbidity in mid afternoon are caused by resuspension by fish and other benthic bioturbators. Chlorophyll a also occurs diurnally, but later in the day. These patterns are common in Southwest Florida waters. We examine the effect of diurnal resuspension and mixed tidal currents on the net sediment transport using analytical and numeric modeling. We also discuss changes in phytoplankton community distributions as a function of this diurnal resuspension.

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USE OF SALT-WEDGE INTRUSION BY TEMPERATE SEABASS JUVENILES TO ASCEND TO UPPER ESTUARY AREAS IN THE YURA RIVER, JAPAN

Recent surveys have revealed that juvenile temperate seabass Lateolabrax japonicus migrates into upper estuarine areas in early spring. However, the mechanism and role of river ascending are insufficiently understood. In order to clarify the mechanism of river ascending of temperate seabass, hydrographic conditions and distribution of the juveniles were observed from winter to spring in 2009 and 2010 in the Yura River estuary, which is highly stratified due to the small tidal variations and seawater intrudes into the bottom layer of the river as a salt-wedge. The salt-wedge intrusion is mainly controlled by the sea level and river discharge. When river discharge was low and sea level was high, a salt-wedge regime was established. Seawater intrusion into the river was however restricted, when the river discharge was high and sea level was low. This regime shifts in early spring, when the larvae and juveniles accumulate around the estuary. There was no difference in the sea level between the two years. However, the river discharge was large with frequent peaks in 2010, while small in 2009. Seawater subsequently intruded into the river through the bottom layer as a salt-wedge in March 2009. In contrast, the river was occupied by freshwater in March and most of April 2010. The seabass juveniles were distributed in the sea and the lower estuary (from the river mouth to 4 km upstream) in March 2009. Then juveniles appeared in the upper estuary from April, corresponding to the progress of the salt-wedge. In 2010, on the contrary, juveniles remained around the river mouth in March, and after that began to ascend the river in April coinciding with the time when the salt-wedge started to intrude. These results indicate that the distribution of juveniles is dependent on the extent of the seawater intrusion into the bottom layer in early spring. Temperate seabass juveniles are concluded to utilize the salt-wedge as a mechanism for ascending to upper estuarine areas.

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EFFECTS OF ARTIFICIAL OYSTER REEF MATERIAL AND AGE ON OYSTER POPULATION AND NEKTON COMMUNITY CHARACTERISTICS IN THE NORTHERN GULF OF MEXICO: A SPACE FOR TIME ANALYSIS

Oyster reefs are one of the most imperiled marine habitats globally with less than 15% of historical populations remaining. Reefs provide numerous ecosystem services, including water filtration, shoreline protection, and habitat for nekton. Along the northern coast of the Gulf of Mexico (GoM), over 200 artificial reefs have been created in recent years in an effort to enhance and restore oyster reefs. Despite this large investment, few studies have examined the success of such efforts over the long term. Specifically, while these artificial oyster reefs have been created from various materials, the most prevalent being oyster shell or limestone and concrete, no consensus exists regarding which material type works best, and few data exist on the long-term sustainability and development of the reefs over time. This study compares the composition and condition of oyster populations and nekton communities on artificial reefs of various ages and two materials (shell, limestone/concrete) to evaluate the development of reefs, and the provision of habitat for nekton over time. Eight different-aged artificial reefs of each the materials (oyster shell, limestone/concrete) and eight natural reefs (control) were sampled (N=21) from Texas to Florida using gillnets, shrimp trawls, cast nets, baited crab traps, deployment plates, and gaged counts. Local habitat conditions (water quality, habitat characteristics), nekton abundance, diversity and community assemblages are being compared to determine the effects of reef material and reef age on habitat provision services. Furthermore, oyster density, size and condition are compared to examine differences by reef material and age, and the combination of reef material by age. These results shed the material type and time effect on the ability of artificial reefs to support oyster populations and nekton communities. This information will aid resource managers working to restore degraded oyster habitat and lost ecosystem services.

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EELGRASS (ZOSTERA MARINA L.) MONITORING IN GREATER PUGET SOUND (WASHINGTON, USA): PROJECT DEVELOPMENT AND RESULTS

Yearly monitoring of eelgrass (Zostera marina L.) beds provides valuable information on ecosystem health. Since 2000, the Submerged Vegetation Monitoring Project (SVMP) has monitored status and trends in eelgrass area and depth distribution throughout greater Puget Sound (Washington, USA) using underwater videography and a high resolution echosounder. The SVMP experimental design and statistical framework provide estimates of eelgrass area and maximum and minimum bed depth at multiple spatial and temporal scales from random samples. Monitoring results are based on extensive sampling: 108 sites were sampled over 55 days in 2010. In addition to annual sound-wide monitoring, one of five regions in the study area is sampled with greater intensity each year. The results show that...
there has been a pattern of losses throughout Puget Sound at sites that typically support eelgrass, but these losses have not affected the overall sound-wide eelgrass area estimate. Areas with declines in eelgrass abundance suggest a changing system, likely the result of localized anthropogenic activities or broader climatic influences, and need to be further investigated to identify specific factors that affect this important habitat. Our well-established monitoring project has worked closely with citizen groups, local governments, and state agencies to assist in tracking eelgrass in locations specific to their interests. Consequently, the data from the annual eelgrass monitoring is directly connected to the establishment of indicators and targets for eelgrass and developing strategies for nearshore management throughout Puget Sound. With an increased focus to assess the condition of Puget Sound, the project has developed techniques to monitor other important marine vegetation and is designing a geospatial database and web-based atlas that will facilitate data management and dissemination.

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ADAPTING COASTAL AGRICULTURE AND ECOSYSTEM SERVICES TO SEA-LEVEL RISE: A ROLE FOR SEASHORE MALLOW

Clearing for farming by early settlers. When storm-driven tides, from a now higher sea, flood these fields their productivity is lost because of salinization and over time they become wastelands of invasive species. These fields are close to markets in coastal cities and require less synthetic fertilizers and supplemental irrigation than drought-prone soils. Their loss when energy costs are high and fresh water for irrigating is scarce is not environmentally or economically acceptable. What is needed is a salt and periodic waterlogging-tolerant plant that can serve both ecological services during emergency conditions and has potential for salt marsh development. Seashore mallow (Kosteletzkya pentacarpos), a brackish marsh deep-rooted perennial dicot producing an oilseed on branching semi-sticky stems is a candidate for this role. We are examining its ecological services, e.g. carbon sequestration (root system), buffer zone functions (nutrient removal, dike alternative) and its economic services, e.g. oil and meal from seeds, fiber and cellulose from stems, carbon credits for sequestered carbon, savings on commodity production and product shipping. The seeds contain approximately 19% oil and 30% crude protein. The fatty and amino acid profiles are similar to those from cotton. Biodiesel fuel was made from the oil and feed pellets from the meal. Stems contain both bast and core fibers. Paper and oil-absorbent matting are among the potential products evaluated and ethanol potential is being investigated with collaborators. Concurrent with evaluating the useful services, we have adapted farm equipment to handle cultivating mallow, e.g. no-till planting, weed suppression, fertilizing with nuisance macroalgae, cutting, and combining, along with changes in standard equipment.

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CAN SALT MARSH PLANTS HELP YOUR COMMUNITY ADAPT TO POPULATION GROWTH AND CLIMATE CHANGE?

Humans have adapted to climate change over the millennia by changing their way of living or by moving. The latter approach has been made difficult by the burgeoning world population. Consequently, adapting increasingly depends on changing our ways of living. Some changes can reduce the rate of climate change and others that of population growth. Regardless of these efforts, change will be part of the foreseeable future. We need to adapt to the stresses of population growth and climate change by changing our reactions to environmental and societal issues as they present themselves. Among the current issues for coastal communities are higher energy costs, limited freshwater resources, nutrient runoff and erosion along waterways, and periodic inundation due to sea level rise of public and private property. Salt marsh plants can be helpful in addressing aspects of all of the issues listed above. Over millions of years these plants have evolved a diverse suite of features that enable them to deal with saltwater-saturated, unstable, muddy soils. The variety of Phragmites australis known as Stripes, which offers environmental safeguards against its spread, can be used to dry biosolids from wastewater treatment with only solar input. Once composted, these biosolids can be used as fertilizer. Many shrubs, grasses, sedges, and herbaceous dicots can be used as landscaping where periodic flooding occurs or brackish irrigation water is available. Buffer strips of selected salt marsh plants along waterways can have aesthetic, as well as functional use in controlling nutrient runoff and erosion. Seashore mallow can be grown on salt-affected public land or private farmland and both its seeds and stems used for biofuel. Its perennial root system provides carbon storage below ground, thereby reducing atmospheric greenhouse gas. The preferred plant selection for each task depends on the location as it does in traditional agriculture and landscaping.

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IMPLICATIONS OF LONG TERM TRENDS IN THE KD-SECCHI DEPTH RELATIONSHIP FOR ECOLOGICAL PROCESSES IN SHALLOW, PHOTIC SYSTEMS

In Chesapeake Bay and several of its tributaries there has been a long-term change in the relationship of Secchi depth (ZSD) to the diffuse attenuation coefficient for photosynthetically active radiation, Kd(PAR). On average, the product of the two, ZSD*Kd(PAR), has declined, indicative of a long-term increase in the light scattering-to-absorption ratio, b/a. If the increased b/a caused the underwater light field to become more diffuse, it would be expected to favor phytoplankton photosynthesis over benthic plants, because phytoplankton behave as spherical light collectors. In this talk, the relative effects of changes in the directionality of the underwater light field on primary productivity by phytoplankton and submerged vascular plants are quantified using radiative transfer modeling. Results indicate that there should be no appreciable effect on the relative efficiency of primary productivity by phytoplankton versus submerged plants. This is because the increase in b/a has been accompanied by a decline in the proportion of light that is scattered in the backward direction. The greatest effect of the increase in the scattering-to-absorption ratio is a reduction of visibility. Contrast reduction theory predicts that this trend may have a greater effect on top-down processes, favoring planktivorous over piscivorous fish, than on bottom-up processes.

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ADAPTING COASTAL AGRICULTURE AND ECOSYSTEM SERVICES TO SEA-LEVEL RISE: A ROLE FOR SEASHORE MALLOW

Because of their proximity to transportation and their agricultural advantages (high nutrients and moisture availability) the low elevation uplands adjacent to estuaries were the first areas

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In large scale sampling strategies time is always one of the major limiting factors especially in intertidal areas due to the daily and seasonal inundation regime. We evaluated the comparability and time-efficiency of two approaches used to quantify bay clam populations – hand digging and venturi suction dredge. In two Oregon estuaries we utilized randomized field sampling to measure clam population metrics. Specifically, we measured abundance, biomass, and shell length for two recreationally/commercially important clam species (Tresus capax, Clinocardium nuttallii) and another common species (Macoma nasuta). The results show that there are no significant differences between the two methods for the two recreational/commercial clam species. However, for M. nasuta populations, significant differences between the methods were found for all three population metrics. The hand dig method underestimated the mean density (by a factor of 3) and biomass (by a factor of 2) relative to the dredge technique. This difference is attributed to a size bias in the dig method which is skewed towards larger clams that are easier to visually detect. The dredge method was also found to be the most time-efficient sampling approach with four times as many samples completed per day relative to the dig method. The results of our experiments indicate that dredge sampling has less bias, produces estimates of clam population metrics comparable to previous estimates using dig sampling, and is a more time efficient approach. These findings will be used in planning future surveys and to aid Oregon Department of Fish and Wildlife shellfish management decisions.

Monitoring of Hydrodynamic and Ecological Restoration in a Cantabric Estuary: Benthic Fauna and Saltmarsh Vegetation

Estuaries are under the negative influence of several anthropogenic activities, which have lead to an unacceptable level of ecological impairment. As a result, restoration is emerging as an important discipline in order to reverse this situation and recover the economic and ecological value of these environments. Hydrodynamic alterations and invasive species are two remarkable pressures that affect estuaries around the world. That was the case of Oyambre estuary, located in northern Spain. Baccharis halimifolia, an invasive species from America, colonized a 67.98% of the total extension of the estuary. Moreover, around 70% of its surface showed a restricted tidal flow due to the presence of dikes. In 2009, three restoration actions were carried out in such a way that B. halimifolia and two dikes were eliminated in order to reduce their impact on the ecological system. Since this year, an adaptive monitoring program has been implemented in order to study the changes and succession in the communities of macroinvertebrates and saltmarsh vegetation. Vegetation is being monitored using transects and permanent plots along the estuary, in which different communities are identified and covered. Samples for the benthic fauna monitoring are taken regularly in two different inundation levels along the longitudinal axis of the estuary. Additionally, a characterization of sediment and water properties is carried out at the same time as the biological monitoring. Finally, the morphological evolution of the estuary, as consequence of the hydrodynamic restoration, is registered using three fixed cameras that take photos each 15 minutes. The analysis of photos and biological samples highlights morphological and biological changes. Nevertheless, the evolution of the system has not been finished since biological communities are not stable. Note the importance of the monitoring as a management tool that will allow the validation of existing predictive ecological models.

Impact of Reduced Seagrass on the Export of Macronutrients and Finfish Production to Offshore Habitats

Shallow coastal embayments with seagrass beds provide a rich, complex habitat for resident, transient and juvenile macroinvertebrates, smaller epifauna and infauna, and finfish. Many juveniles of economically important fishery species preferentially recruit to seagrass beds. However, a recent estimate showed that nearly 50% of the Gulf of Mexico (GOM) estuaries are chemically impaired, and that major losses have occurred in most seagrass meadows. To quantify the impact of seagrass decline on coastal fisheries production in the GOM, we are studying six coastal embayments in northwest Florida that range widely in seagrass cover (0–80%), and are quantifying macronutrient and fish finfish abundance, diversity and biomass seasonally through seine and suction samples in these six lagoons. In all, our abundance results to date suggest that the effects of seagrass loss on macroinvertebrates and finfish in shallow coastal lagoons may be disparate, with some, but not all, species showing reduced abundances. Further analysis of the 2010 collections will include estimates of biomass and secondary production, which will allow us to evaluate the impact of seagrass loss on the annual export of secondary production to offshore habitats.

Community Metabolism and Nutrient Fluxes in Transplanted and Natural Seagrass Beds in Pensacola, FL

Determining whether restored ecosystems have similar functions as natural, undisturbed systems has been an area of concern in restoration ecology. In Pensacola Bay, restoration of seagrass beds has focused on transplants of Thalassia testudinum and Halodule wrightii salvaged from dock and marine construction sites. Transplants have been most successful when planted adjacent to native beds. We compare rates of community metabolism and benthic nutrient fluxes over the growing season, between May and September in natural and transplanted beds in Big Lagoon, Pensacola Bay, FL. Light and dark benthic chambers are placed over native and transplanted beds. Light levels in the beds are measured and total irradiance received by the beds over the course of the incubations will be calculated. We also measure water quality including temperature, salinity, dissolved oxygen, water column chlorophyll a, nitrogen, ammonium and phosphate concentrations. Seagrass coverage in restored and native beds is estimated using the Braun Blanquet method. Pore water ammonium concentrations are always higher than concentrations in the overlying water throughout the growing season leading to release of ammonium across the sediment-water interface. In contrast, dissolved inorganic phosphorus (DIP) in pore water and in overlying water are similar in late summer suggesting that benthic fluxes of DIP are near zero. Understanding whether critical ecosystem functions such as production, respiration and nutrient recycling are similar or different between transplanted and natural beds will help guide future restoration and management efforts in the region.

Nitrogen Demand Indicates Nitrogen Limitation of Microbial Activity in Subsurface Waters and Sediments of the Northern Gulf of Mexico Hypoxic Region

High ammonium (NH4+) demand occurs during summer in the bottom water and sediments of the northern Gulf of Mexico (GOMEX), even though the extent of hypoxia relates to high spring-time nitrate inputs from the Mississippi River. Seasonal measurements of nitrogen (N) and oxygen dynamics provide insights about biogeochemical mechanisms responsible for this seeming paradox. Isotope-dilution experiments, with added 15NH4+, were conducted in bottles for water column samples or by flowing over intact sediment cores for sediment-water-interface (SWI) measurements. The concept of “NH4+
demonstration” defined as “potential NH4+ uptake rate” (with 15NH4+ additions) minus “net NH4+ flux” (ca. equal to net NH4+ regeneration or uptake fluxes) provides a useful approach to examine the degree of apparent ammonium limitation in bottom-water samples and the SWI. Ammonium demand, likely caused by the removal of N via nitrification/denitrification, was observed in the water column and SWI of most NGOMEX stations and was most pronounced during the summer at a station with severe hypoxia (Rabalais-C6). Nitrifying bacteria were comparable to NH4+ regeneration rates in the oxygenated water. Dark-water column NH4+ demand ranged from -0.01 to 0.36 μmole N L-1 h-1 and was highest at C6 in “overlying water” (OLW) collected a few cm above the sediments. Ammonium demand at the SWI ranged from ca. 0 to ca. 300 μmole N m-2 h-1 as compared to denitrification rates of 0 to 500 μmole N m-2 h-1 in the NGOMEX region. In May 2010, stations affected by the Deepwater Horizon oil spill had highest dark NH4+ demand in near-surface water and in OLW, where light and heavy oil components may have accumulated. To conclude, NH4+ limitation caused by nitrification/denitrification may be a crucial factor controlling N-dynamics and the degree of O2 and organic matter depletion in bottom waters and sediments of the NGOMEX hypoxic region.

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NUMERICAL SIMULATION OF DYE TRACER EXPERIMENT IN GEORGIA TIDAL CREEK - MARSH COMPLEX

Numerical simulations were performed of the transport and dispersal of Rhodamine dye tracer in a partially isolated tidal creek – marsh complex on the Georgia coast. The simulations used high-resolution (2 m horizontal nodal spacing) bathymetry derived from ground-based topographic measurements with elevation uncertainties of about 2 cm. The dye tracer was released into the main creek of the system early in a flood tide. The spread of the dye tracer was recorded by 4 recording fluorometers that were deployed in the main tidal creek and its tributaries for several weeks. The spread of the dye was also recorded by photographs taken from a helicopter at frequent intervals during the initial flood tide. The Rhodamine dye spread almost completely through the tidal creek – marsh complex during the initial flood tide. The numerical simulations reproduced details of the spread of the tide, including the transport of dye from the main creek and its tributaries to the smallest creeks that transport the dye into the marsh flats. The numerical simulations accurately reproduced the time series of dye concentrations taken by the 4 recording fluorometers when horizontal nodalization was sufficient to resolve the smallest tidal creeks. Although fairly accurate simulations were possible when 2 m ground-based bathymetry was used to create the computational domain, the density of the Spartina marsh grass and its effect on flow was a crucial factor controlling N-dynamics and the degree of O2 and organic matter depletion in bottom waters and sediments of the NGOMEX hypoxic region.

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ARCHIVING AND RE-USING INTEGRATED CONCEPTUAL Ecosystem MODELS (ICEMS)

A sound ecosystem-based management plan that ensures the coexistence of healthy human communities requires a community-based consensus about the defining characteristics and fundamental regulating processes of the system. The Marine and Estuarine Goal Setting for South Florida (MARES) project represents a collaborative approach between academic, government and non-governmental organizations working in conjunction with resource managers and other stakeholders. The process involves the development of Integrated Conceptual Ecological Models (ICEM) to represent ecosystem dynamics. When combined with associated quantitative ecosystem indicators (QEIs), ICEMs can form the foundation of a powerful decision support system. ICEMs are typically static diagrams with accompanying text and cannot be used directly by a computer or an existing software application. In order to increase usability and facilitate both adoption and enhancement of the models, we describe the application of Web Ontology Language (OWL), a computationally accessible W3C standard language used for knowledge representation, and semantic web applications that can incorporate the concepts and associated meanings as defined in an ICEM. The proposed system (ICEM-CTK) will provide a computationally accessible standard representation with which to build and encode ICEMs and associated QEIs. The ICEM-CTK will enable these conceptual models to be stored and used by software applications for any purpose desired. The ability to archive conceptual models allows models and data to be re-examined, reused and compared. It also facilitates the integration of independently produced sub-scale or sub-process models into larger-scale ecosystem models.
concept will be demonstrated using an ICEM published by MARES, culminating with the generation of an ecological score card, a product proven useful in decision support applications.

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BLURRING THE LINES BETWEEN RESEARCH AND EDUCATION - UNDERGRADUATE ENGAGEMENT IN COASTAL MARINE RESEARCH PROGRAMS AT COASTAL CAROLINA UNIVERSITY

For two decades, undergraduate students have been broadly engaged in research activities within the Center for Marine and Wetland Studies affording substantial educational opportunities "beyond the classroom." This has resulted in more than 500 undergraduate students going to sea on federal and university ships for multi-day trips in groups of one-to-four students at a time and larger numbers participating in a number of day-trip excursions. Most are extensively engaged with preparation for the fieldwork and subsequent data processing, lab work, analysis and presentations; both independently and as part of the larger research team. Students participate in three general scales of activities: 1) initial field opportunities-many tied to a number of specific classes, 2) specific directed undergraduate research projects, and 3) sustained "research assistant"-type positions over two-to-three year periods working on many different projects, in diverse focus areas and with a wide range of faculty and staff. Initial field opportunities are provided though fieldwork associated with specific grants and informal weekend excursions. Directed undergraduate research projects operate as traditional RUE type experiences focused on a particular project. Students who become involved early in their studies typically work on a wide range of projects and obtain more diverse and sophisticated skills and experiences. These experiences have served well in fostering multidisciplinary approaches to complex marine problems, engaging more diverse expertise inside and outside the Center and University as well as help students more fully consider potential focus areas for their studies. A large majority of these more engaged undergraduates have continued on to graduate pursuits at top grad programs in the country citing the benefits of the graduate culture in an undergraduate setting. This "beyond the classroom" culture has been an important part of student and Center success.

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MEASURING POTENTIAL DENITRIFICATION ENZYME ACTIVITY RATES USING THE MEMBRANE INLET MASS SPECTROMETER

The denitrification enzyme activity (DEA) assay provides an assessment of the multi-enzyme, biological process of reactive nitrogen removal via the reduction of nitrate to nitrogen gas. Measured in soil, usually under non-limiting carbon and nitrate concentrations, this short term laboratory assay (6 hours) provides quantitative information on the DEA rate potential in the soil at time of sampling. DEA is related to size of the denitrifying enzyme pool and yields an index of the denitrifier population in soils that is reflective of long term in situ denitrification rates. DEA is commonly measured by the production of nitrous oxide that accumulates due to acetylene inhibition of the enzyme nitrous oxide reductase. Nitrous oxide is readily measured by gas chromatography. Without using an acetylene block the small amount of the major end product nitrogen gas is difficult to measure because of the high background of nitrogen that exists in the atmosphere. Other methods have been used to measure denitrification. Using the membrane inlet mass spectrometer (MIMS) background problems are reduced by measuring an increase in the ratio of dissolved nitrogen/argon in the DEA solution over time. Advantages of utilizing the MIMS are rapid throughput, small sample size, high precision and the ability to measure several gasses including nitrous oxide. Presented is our approach for measuring rates of DEA in surface soil samples using the MIMS. Reaction vessel design, sampling regimes, rate calculations, appropriate controls and data quality objectives are examined and discussed.

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DIFFERENTIAL SEDIMENTATION IN A MISSISSIPPI RIVER CREVASSE SPLAY

In this study the patterns of sediment transport and deposition in the channels and receiving basin of a crevasse splay in the modern Mississippi River delta are examined, with emphasis on the development of a distributary mouth bar. Simultaneous hydroacoustic and optical measurements on the mouth bar show that the bar conforms to the progradational stage of an existing conceptual model of mouth bar development. This is confirmed by cores dated using Beryllium-7, which provides a record of the deposition on the bar over a 90-day period. Stratigraphic data from cores obtained on the bar are used to extend the conceptual model to account for variable riverine inputs. A numerical model, developed and validated using field data is capable of reproducing the fundamental sedimentary processes responsible for mouth bar progradation.

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DOES SUBSIDY OF OYSTER SEED ONTO CREATED REEF STRUCTURES ENHANCE OYSTER POPULATIONS?

As a result of the drastic declines in oyster populations, both private and governmental organizations have invested substantial resources into oyster reef restoration. North Carolina has set up a system of subtidal oyster sanctuaries (no oyster harvesting) in the Pamlico Sound, which consist of many (>50) large mounds (2m high) of marl rip-up. In addition, North Carolina has devoted resources to seeding sanctuary mounds, as well as harvested areas, with hatchery-raised juvenile oysters with incomplete evidence on whether seed oysters accelerate reef creation and, if so, what size and time of deployment maximizes survival. Three sanctuaries with different salinities were seeded during the summer of 2010. Each sanctuary received a different treatments varying seed and shell presence, seed size, and deployment date. Three types of predator exclusion cages were also deployed on experimental mounds to measure top-down effects on seed oyster survival. In addition, 7 additional sanctuaries were monitored from May 2009 to Nov. 2010. Monitoring included measuring recruitment to settlement plates and marl; environmental variables (salinity, temperature, current, nutrients); and predation (using settlement bins, crab traps, and gillnets). Settlement did vary spatially, but recruitment was not limiting and natural recruitment overwhelmed any benefit of seeding, although addition of an oyster shell veneer can increase recruitment. Only the smallest mesh cages increased juvenile oyster survival. Our findings, along with information on oyster recruitment from past years, indicate that the addition of shell to these new re-creation sites is not limiting to near-zero seed recruitment and resources should be devoted to providing substrate to optimize oyster restoration.

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EFFECTS OF TROPICALLY ASSOCIATED GRAY SNAPPER (LUTJANUS GRIESEUS) AND LANE SNAPPER (LUTJANUS SYNAGRIS) ON GROWTH RATES OF NATIVE PINFISH (LAGOONODI RHOMBOIDES)

A significant effect of climate change on the structure of ecological communities is poleward shifts in species distributions, which may have profound effects on community ecology. The Gulf of Mexico (GOM), with tropical habitats in the south and sub-tropical habitats in the north, offers a unique opportunity to study impacts of species shifts. Poleward shifts in the GOM are geographically restricted by North America; thus, endemic communities in the northern GOM will likely be impacted by tropical species expanding north. In 2010, Fodrie et al. quantified changes in fish communities in the northern GOM in the last 30 years. Juvenile gray snapper increased 105-fold to the 7th most abundant species. Lane snapper, absent in the 1970s, increased significantly to the 8th most abundant species. In this study we examined sublittoral aspects of these tropical species on pinfish, the most abundant native species inhabiting seagrass meadows. Specifically, this study addressed the questions: 1) How does pinfish growth vary among locations in the northern GOM?, and 2) Is pinfish growth negatively affected by gray and lane snapper? To answer these questions we used a before-after-control-impact (BACI) design comparing both locations and seasons with and without snapper. Pinfish were collected by trawling in 6 locations in spring when juvenile snappers were absent, and again in fall after the arrival of snappers. Three sites served as control sites (no snapper in either season) and 3 were impacted sites (snapper present in fall). Pinfish growth rates were determined using otolith microstructure analysis by measuring from the otolith margin in 14 daily growth increments, corresponding to the last 2 weeks of growth. Preliminary results suggest no significant difference in pinfish growth rates in control and impact sites in spring, but significantly slower growth in impact sites in fall when snapper were present, likely due to competition between pinfish and snappers.

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MAPPING OF SEDIMENT AND BENTHIC CONDITIONS AROUND THE DEEPAWATER HORIZON ACCIDENT SITE

In Spring 2011, as part of a cooperative effort by BP and Federal Trustees to assess the potential effects of the Deepwater Horizon accident on the natural resources of the deep benthic sediments, a study team mapped the extent of deposits that may have resulted from drilling and well control activities in the area surrounding the MC-252 wellhead. The study used a Sediment Profiling and Plan View Imaging (SPI/PVI) camera system to collect both surface and cross-sectional images of seafloor sediments in approximately 1,500 meters of water. The study complements previous and planned studies of sediment PAH concentrations and benthic infaunal community structure in the area around the wellhead. Comparison studies include (1) historical studies conducted by the Bureau of Ocean Energy

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management, regulation and enforcement (BOEMRE) (2) recent studies by the unified area command operational science advisory team (OSAT), and (3) a follow-up study by BP and the federal trustees in spring 2011. The talk presents the results of the SP/IV study and correlations between sediment PAH concentrations published by the OSAT and by the historical BOEMRE studies. The talk also discusses planned analyses correlating the SP/IV results with infaunal community and sediment chemistry results from the Spring 2011 follow-up study.

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OVER-MIXED OR OVER-PUMPED? TIDAL INFLUENCE ON ESTUARINE EXCHANGE FLOW

Over-mixing theory (Stommel and Farmer '52) predicts an upper limit on estuarine exchange, based on maximal hydraulic exchange flow. However, this theory does not account for the direct contribution of tides to the exchange flow. We used a quasi-Lagrangian approach called “total exchange flow” or TEF, in which salt flux is estimated as a function of salinity, to determine the relative contribution of tidal to density-driven exchange in real and idealized estuaries. We find that tidal exchange can greatly exceed the density-driven exchange. We call this the “over-pumped” condition. Over-pumping is most marked in shallow estuaries with constricted mouths. In these environments, tidal processes totally dominate over density-driven exchange. For deeper estuaries such as fjords with constricted mouths, over-pumping may still occur near the mouth, but within a small fraction of the tidal excursion the exchange flow becomes dominated by density-driven shear flow. In shallow estuaries, the tidal exchange at the mouth is coupled to the interior of the estuary via mixing and stirring across a laterally dispersing frontal zone. For deeper, fjord-type estuaries, the coupling to the interior of the estuary involves frontal hydraulic processes.

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DESIGNING INTEGRATED COASTAL MAPPING FOR THE GULF OF MEXICO

Integrated coastal mapping (ICM) occurs across jurisdictional boundaries using data types and acquisition parameters that satisfy as many management needs as possible. Regional ocean governance can provide a framework to facilitate ICM and hence the efficient acquisition and quality of mapping data. The Gulf of Mexico Alliance (GOMA) is a consortium organized by the governments of the five Gulf States with strong support from federal agencies. Local governments, NGOs, and universities are also active participants in GOMA. GOMA is addressing the implementation of ICM through several efforts including (1) determinations of the types and spatiotemporal resolutions of data required to address management issues, (2) cataloging existing mapping datasets and making them discoverable by the public (3) identification of current data gaps, (4) inventory of current capabilities and ongoing mapping programs, and (5) an interactive web application for collaborating on data acquisitions. Results of these efforts are part of a Gulf-wide plan that presents a strategy for ICM.

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DENITRIFICATION IN SALT MARSH SEDIMENTS: FINDING THE “HOT SPOTS AND HOT MOMENTS”

Denitrification rates in salt marshes are high compared to most other marine environments. We have been measuring denitrification rates in creek sediments, estuarine channels and vegetated marsh sediments in a large marsh estuarine complex in Massachusetts. Denitrification rates are spatially and temporally variable. For example, rates in small tidal creeks were 4-6 times higher than near an arable basin than in the adjacent high marsh. In addition, temporal patterns vary spatially, rates tend to peak in early to mid-summer in the lower estuary while the highest rates are in the spring and fall in an upper estuarine site. Controls on denitrification rates in these different areas also vary; some areas show good relationships between sediment oxygen demand (SOD) and denitrification rates while denitrification rates in other habitats are relatively uncoupled from SOD. However, when all habitats are combined SOD is not a good predictor of denitrification. The effect of salinity also shows large spatial variability, being highly predictive in the upper reaches of one estuary and apparently not a factor just a bit further downstream. The complex response of denitrification to changes in environmental variables appears to be at least in part to differences in the relative importance of direct denitrification, coupled nitrification/denitrification and dissimilatory nitrate reduction to ammonium in different habitats. Because the controls on each of these processes is different, the denitrification rate in each habitat shows a different degree of sensitivity to changes in an environmental variable. The net result is that predicting the whole ecosystem denitrification rate from individual sites is challenging. However, it also suggests that if this pattern is typical, spatially complex marshes may processes nitrogen inputs more effectively than systems with a limited number of habitat types.

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RESIDUAL CIRCULATION IN ESTUARIES THAT ARE SHALLOW RELATIVE TO THEIR TIDAL AMPLITUDE: COMPARISON OF EULERIAN AND LAGRANGIAN APPROACHES

Traditional analyses of residual circulation in estuaries rely on the assumption of a small tidal amplitude relative to the estuary depth, however, many estuaries break this assumption. We investigate the residual circulation in a macrotidal, shallow salt wedge estuary which has a tidal range comparable to its mean depth. We show that the residual circulation computed in an Eulerian reference frame can be misleading and does not correspond to the residual transport velocity of salt or particles. Rather, we identify a method utilizing a depth-normalized coordinate system to compute an approximate Lagrangian residual that can be broken into a Stokes transport term and an Eulerian component. Finally we use an empirical orthogonal function analysis to illuminate the physical mechanisms that drive the shape of the residual profiles in both the depth-normalized coordinates and in the Eulerian reference frame. Importantly we emphasize the problems that can arise in an Eulerian reference frame and suggest that the approximate Lagrangian residual is at least a first step to an improved interpretation of the residual circulation in estuaries that are shallow relative to their tidal amplitude.

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A HIGH CO2 WORLD: METHOD DEVELOPMENT INVESTIGATING ALTERATIONS IN PHYTOPLANKTON COMMUNITIES ON A REGIONAL SCALE

Global climate change is caused by increases in greenhouse gases such as carbon dioxide (CO2). Evidence has shown that elevated concentrations of atmospheric CO2 may lead to substantial shifts in the carbonate chemistry of aquatic and marine environments, which in turn causes a decrease in pH. The field of ocean acidification currently lacks a uniform method of CO2 perturbation and has thus made it difficult to compare microbial community shifts across sites. This study attempts to investigate the success rates of two method treatments to simulate decreases in pH based on the estimates of atmospheric CO2 concentrations (750ppm) by year 2100. The two treatments, pure CO2 injection and acid/bicarbonate additions, were chosen because the shifts the carbonate chemistry most closely mimic natural conditions while keeping alkalinity constant. Both methods were conducted in laboratory and in situ conditions, using a floating enclosure to ensure the experiments had ambient light and temperature conditions. Currently, most research has occurred in marine systems and little research has focused on phytoplankton community changes in freshwater systems. Thus, this study investigates changes in both systems, with one freshwater site (James River, VA), and one saltwater site (Duck, NC) that were chosen to evaluate regional changes of phytoplankton communities over time with decreased pH. Preliminary results have shown differences in both fresh and saltwater over a period of 4 days in phytoplankton nutrient uptake, C:N and community size shifts, based on flow cytometry. Comparing the two methods, the CO2 injection system sustained a more constant pH for a period of 3 days than the acid addition method. With both methods, the in situ experiments produced more consistent results than the laboratory experiments. Based on this study, it is recommended that future studies utilize the in situ based CO2 injection system method.

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POPULATION GENETICS OF A NEW INTRODUCTION: GREEN MUSSELS IN THE WESTERN HEMISPHERE

Population genetics tools can often be used to determine the source(s) of introduced populations and to compare the amount of genetic variation in these populations to those in the native range. It is often hypothesized that newly founded populations will contain a subset of the genetic variation present in the source population and, therefore, less overall variation. Offentimes, however, studies of invasive species show no significant loss of genetic variation, and may even show greater genetic variation than is found in native populations. The green mussel, Perna viridis, is native to the Indo-Pacific and was first found in the Western hemisphere in 1990 in coastal waters of Trinidad. Since that time it has been
found in several other sites throughout the Caribbean and in coastal waters of Florida and Georgia in the United States. These introduced populations are often separated by several hundred km of uninhabited area. We collected samples from five introduced populations and three populations within the native range in order to test whether all of the introduced populations stem from the same initial introduction, or whether they are the result of multiple independent introductions. The amount of genetic variation was also compared between introduced and native populations to test for the presence of a founder effect. All introduced populations were genetically similar suggesting a single initial introduction that has since spread to each of the various sites. Furthermore, measurements of genetic variation typically suggested that introduced populations had lower overall variation than did populations in the native range.

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USING MACROBENTHIC COMMUNITY STRUCTURE TO DETECT EUTROPHICATION IN SOUTHERN CALIFORNIA ESTUARIES, BAYS, AND HARBORS

Although the use of macrobenthos to assess general environmental condition is well established, there has been comparatively little development of macrobenthic-based tools for the diagnosis of individual stressors. Eutrophication is arguably the most pervasive stressor impacting the quality of estuaries and coastal oceans around the world. There have been a number of conceptual models developed to describe changes in macrobenthic community structure in relation to eutrophication and organic matter enrichment; however, few tools have been developed that quantify this relationship. Our goal was to develop practical tools that use macrobenthic community structure to assess the eutrophic status of the sediments and overlying waters of the estuaries and coastal ocean of the Southern California Bight. We created a series of metrics based on macrobenthic community structure (e.g., relative abundance of indicator taxa, dominance and abundance ratios of different feeding guilds, etc) and tested their ability to detect indicators of sediment eutrophication (elevated TOC and TN) compared to other stressors. In preliminary analyses, several metrics have yielded promising results and are being tested for broader applicability. These macrobenthic community metrics will potentially be included in the state of California’s forthcoming biologically-based nutrient and eutrophication evaluation program.

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THE GK-12 PROGRAM AT COASTAL CAROLINA UNIVERSITY: LINKING ESTUARINE RESEARCH WITH SCIENCE EDUCATION

The GK-12 Fellows program at Coastal Carolina University (CCU) pairs Masters students with local high and middle school science teachers to bring inquiry-based science education to the local schools. The Fellows (graduate students) develop inquiry-based lessons and activities that are based on their ongoing thesis research. Since all the Fellows research is field based, the Fellows also design field trips for their classes in an assimilate of marine, estuarine and wetland environments. While the focus of the program is centered in the classroom during the academic year, the program at CCU has a unique component to strengthen collaboration between marine researchers and educators. One option for the GK-12 teachers is participation in summer research with their Fellow the summer before the Fellow assists in the classroom. The teachers spend 120 hours during the summer assisting the Fellow in designing experiments, collecting data in the field, and analyzing data in the laboratory. In addition to aiding the progress of the Fellows’ thesis work, this opportunity allows for dialogue, bonding, planning, and collaboration between the Fellow and his/her partner on ideas for bringing research into the classroom.

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FLORIDA EAST COAST LAGOON FISH ASSEMBLAGES: 56 YEARS OF RESEARCH

Robert Harrington began quantitative studies of estuarine fish assemblages in east central Florida in 1955, focused on freshwater tributaries and tidal wetlands. Nearly all tidal wetlands of central Florida’s Indian River Lagoon (IRL) were impounded for mosquito control, with significant impacts on wetland fish populations. In 1971, I began comprehensive exploratory and quantitative fish research in freshwater tributaries, tidal and impounded wetlands, seagrass, nearshore reefs, continental shelf sand, mud reef and deep-slope habitats, as a major part of the Indian River Coastal Zone Study (IRCZS), a 10-year interdisciplinary study by Harbor Branch Foundation and Smithsonian Institution. Over 100 scientists conducted collaborative studies from the continental shelf to tidal wetlands over 225 coastal kilometers; a rich, previously unrecognized center of U.S. estuarine biodiversity and several new fish species were described. The IRCZS revealed exceptionally high local floral and faunal biodiversity, particularly in the IRL’s southern half and coastal reefs; these unique biotic communities led to the inclusion of the IRL in EPA’s National Estuary Program. Recent work is documenting new regional fish records with faunal affinities to the Greater Antilles and Central America and problematic exotic fishes. These studies have documented localized species extirpation, substantial habitat and water quality decline, increase in fish disease incidence, toxic algal blooms and extraordinary population explosions in exotic species. These impacts have been particularly damaging in the southern IRL which historically had the highest aquatic biodiversity. These declines are directly associated with extraordinary increases (500%) in resident human populations and their impact on aquatic resources, e.g., freshwater management, increased water pollutant loading, fisheries (recreational and commercial), coastal sand shoal removal and beach sand deposition.

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HABITAT ASSESSMENT: SUPPORTING ADAPTIVE HABITAT RESTORATION AND LIVING RESOURCE MANAGEMENT IN CHESAPEAKE BAY

The NOAA Chesapeake Bay Office (NCBO) performs habitat assessments on a range of Bay habitats including historic oyster bottom, native oyster restoration projects, and sturgeon spawning grounds; collecting, analyzing, and reporting the best available information on habitat impacts to the public as they relate to the population dynamics of Chesapeake Bay resources. The approach couples acoustic seafloor mapping of benthic habitats with biological assessments. NCBO also created a hierarchical classification scheme that conforms to Coastal and Marine Ecological Classification Standard (CMECS-v5.1 Aug. 2010) to classify Bay benthic habitat. Broad scale mapping integrates sidescan sonar backscatter, seabed classification and geo-referenced underwater videography and direct sampling ground-truth data. The product is a GIS layer that identifies the distribution, extent, and composition of bottom materials to be used for habitat restoration site selection and identification of population survey sampling boundaries. Shallow water multibeam sonar systems provide high resolution depth and backscatter amplitude data to identify and monitor morphological change. The data informs the oyster restoration site selection and design process, defines the as-built condition of constructed reefs, identifies hazards to navigation, and supports the creation of habitat complexity metrics such as surface area change and habitat ruggedness. By collecting baseline and follow-up multibeam bathymetric data, the efficacy of restoration projects can be evaluated periodically; surveys provide the basis for monitoring reef growth and/or degradation over time. The comprehensive information that NCBO develops is used in a collaborative, adaptive management framework with partner agencies and organizations to enhance their ability to manage, protect, and restore critical habitat.

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IDENTIFYING POTENTIAL ROUTES OF HEMOLYMPH INFECTIONS IN CALLINECTES SAPIDUS THROUGH CHARACTERIZATION OF THE MICROFLORA COMMUNITY OF THE CARAPACE, GUT, AND HEMOLYMPH

The Atlantic blue crab, Callinectes sapidus, is edible and a profitable seafood product. Previous culture-based studies have found potential pathogens associated with gills, viscera, processed meat, and the hemolymph of apparently healthy crabs. It is often thought that sterile hemolymph indicates a healthy crab, whereas bacteria within the hemolymph are an indicator of disease. Many previous studies of crab microflora have relied on culture-dependent techniques, which are limited by the ability of researchers to culture fastidious organisms. This research uses 16S rna genes in applications of 16S rDNA clone libraries and quantitative PCR (qPCR) to characterize and quantify the baseline microflora communities of the C. sapidus carapace, gut, and hemolymph. Defining these microbial assemblages will help determine potential sources and pathways of hemolymph infections. Increased occurrences and abundance of certain bacteria (e.g. Vibrio spp., Photobacterium sp., Mycoplasma sp.) in the hemolymph could impact not only crab physiology, but also public health through food transmissions and wound infections. Sequence data suggests that the hemolymph microflora is dually dominated by Bacilli (Bacillus sp.) and γ-Proteobacteria (Vibrio spp.). The gut microflora appears to be dominated by γ-Proteobacteria (Vibrio spp. and Photobacterium sp.). γ-Proteobacteria (mainly Alteromonas sp.) contribute heavily to the carapace microbial community. Further analysis of these samples will provide information regarding the diversity and potential pathogenicity of microflora associated with the blue crab qPCR data will allow comparison of bacterial concentrations associated with the carapace, gut, and hemolymph. Results from these analyses will provide insight into the presence and abundance of potential bacterial pathogens associated with blue crabs that may be intended for human consumption.
INVESTIGATION OF FISH INTESTINE AND SEDIMENT AS POTENTIAL RESERVOIRS OF VIBRIO VULNICUS AND VIBRIO PARAHEMOLYTICUS

Vibrio vulnificus (Vv) and Vibrio parahaemolyticus (Vp) are Gram-negative bacteria native to estuaries in the Gulf of Mexico. These bacteria are also human pathogens, associated with the consumption of raw oysters in warm months. This research aimed to examine fish intestine and sediment as a potential reservoir for Vv and Vp during times of the year they are not detectable in oysters. We quantified these pathogens in fish intestine, sediment, oyster, and water samples from a site in Mobile Bay. Densities of Vv and Vp in all samples were determined through quantitative PCR (qPCR) and colony hybridization. During the study, water temperature at the sampling site varied from 20.1-24.6°C and salinity ranged from 3.7-18.8 ppt. Highest densities of Vv and Vp were detected with water temperatures >22°C and salinity >10 ppt. By qPCR, Vv and Vp were detected in 76 and 48% of fish intestine, 73% and 36% of water, 18% and 27% of sediment, 8 and 8% of oyster samples, respectively. Higher detection rates of Vv and Vp were obtained by colony hybridization due to the lower limit of detection (10 CFU/g vs. ~500 CFU/g). Overall, Vv was detected at higher densities than Vp. Vv densities were greater by qPCR than colony hybridization, perhaps due to inhibition of the plating media causing decreased recovery of stressed cells. This difference was greatest in fish intestine samples, possibly due to a higher number of stressed cells than in other sample types. These results provide insight into the effect of water temperature and salinity on Vv and Vp densities in fish intestine, oyster, water, and sediment. The data indicate fish intestines and sediment may be reservoirs for Vv and Vp during periods of sub-optimal temperatures (<22°C) and/or salinity (<7 ppt), when oyster-associated illnesses are typically reported. Abundance of the pathogens Vv and Vp in the environment can potentially affect human health, and subsequently, the commercial fishing and aquaculture industry.

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WATER QUALITY CHARACTERIZATION AND 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. Double Bayou has two forks, the West Fork (listed as impaired since 2004) and the East Fork (a scenic waterway used for recreational purposes), which converge above the mouth of the Bayou on the eastern shoreline of Trinity Bay. The watershed has an extensive network of rice irrigation canals as well as some channelized waterways that alter the natural drainage pattern of the watershed. Oil and gas wells are scattered through the area. Topography in the watershed is generally very flat. 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 addresses the current water quality problems of reduced dissolved oxygen (DO) and elevated bacteria in the bayous, as well as lays the groundwork for implementation of strategies to restore water quality through the development of a Watershed Protection Plan for Double Bayou. Initial data analysis from the Fall sampling event of the watershed characterization showed that extremely low DO, elevated bacteria concentrations and elevated chlorophyll-a levels occur in both bayous, and at both the tidal and non-tidal sampling stations. This discussion will focus on the spatial and temporal trends in water quality data for this tidal watershed over the historical record and changes in the watershed as population grows and land use alteration occurs. In addition, we discuss challenges in presenting the data to a diverse group of stakeholders in a coastal watershed.

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ELESTICAL STOCIOCHIMETRY, PRODUCTIVITY AND FOOD WEBS: INTRODUCTION TO THE SESSION

The balance between major nutrient elements has long been known to be a major controlling factor in primary production. What we are now beginning to understand is the extent to which elemental stoichiometry shapes food webs, from bacteria and phytoplankton (including HABs) to fish. There are numerous examples of relationships between altered nutrient stoichiometry and phytoplankton community composition. Not all species follow the canonical Redfield relationship. Less well appreciated is the fact that the relative availability of nutrients also exerts considerable influence on higher trophic levels. Many anthropogenic forces are changing the balance of nutrient loads in estuarine systems: point and non-point sources of nitrogen continue to be high in many regions, while phosphorus control has been undertaken throughout much of the U.S. This introduction will outline why ecological stoichiometry is of concern and the consequences of a stoichiometric perspective for how we conceptualize ecosystem dynamics.

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DO EXTERNAL NUTRIENT RATIOS MATTER? LOOKING BEYOND GROWTH AND PRODUCTIVITY: A STOCIOCHIMETRIC PERSPECTIVE

There has been much debate about nutrient regulation and limitation and the potential importance of N vs P limitation in waters from fresh to marine systems. Moreover, the question frequently arises as to whether nutrient ratios have impacts on phytoplankton when the concentrations of those nutrients are at levels normally taken to be above those that are limiting. From the perspective of phytoplankton growth rate regulation, it is nutrient concentrations and not their ratios that are controlling; this is without question. However, at saturating nutrient concentrations, organismal ratios of C:N or N:P can continue to vary due to physiological plasticity, although the extent to which this occurs varies by species and other factors. Consequently, trophic transfer of phytoplankton energy (C-based primary productivity) and materials (N and P) are regulated differently. Are there consequences to food webs for changes in elemental stoichiometry of biomass at nutrient saturation? Grazers will, in fact, obtain food of different quality (at the elemental level and potentially species level) at different ambient levels of N and P when even algal growth is nutrient saturated. Both grazer size and their elemental composition are strongly related to N and P stoichiometry, more so than phytoplankton. Thus, while C flow through the ecosystem may control rates of primary production, N and P availability and form may control species composition beyond the primary producer level. The implications for management are important, as a C-only perspective will lead to the assumption that because nutrients are in excess they are not regulating the food web above the primary producer. Ecological stoichiometry suggests that the relative availability of N and P, in addition to their absolute concentrations, affect community structure at all levels. These principles will be illustrated with data from the San Francisco Bay Delta and other estuaries undergoing changes in N and P loads.

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BARIUM PEAKS AND ENVIRONMENTAL VARIABILITY RECORDED IN BLACK (SEBASTES MELANOPS) AND CANARY (SEBASTES PINNINGER) ROCKFISH OTOLITHS

High-resolution barium profiles in biotic carbonates such as corals and bivalve shells often show periods of relatively stable barium concentration punctuated by infrequent, yet anomalously high peaks. These peaks are temporally synchronous among individuals, indicating that they may be a result of environmental variability. A similar pattern has been observed in otoliths of black (Sebastes melanops) and canary rockfish (S. pinniger) from the coast of Oregon. Within the California Current ecosystem, seasonal upwelling supports productivity in waters from fresh to marine systems. Moreover, the balance between major nutrient elements has long been known to be a major controlling factor in primary production. What we are now beginning to understand is the extent to which elemental stoichiometry shapes food webs, from bacteria and phytoplankton (including HABs) to fish. There are numerous examples of relationships between altered nutrient stoichiometry and phytoplankton community composition. Not all species follow the canonical Redfield relationship. Less well appreciated is the fact that the relative availability of nutrients also exerts considerable influence on higher trophic levels. Many anthropogenic forces are changing the balance of nutrient loads in estuarine systems: point and non-point sources of nitrogen continue to be high in many regions, while phosphorus control has been undertaken throughout much of the U.S. This introduction will outline why ecological stoichiometry is of concern and the consequences of a stoichiometric perspective for how we conceptualize ecosystem dynamics.
that variation in oolith Ba-Ca (1.5-40 μmol mol⁻¹) exceeds variation in water Ba-Ca (4-12 μmol mol⁻¹), additional research is needed to identify the mechanisms regulating barium incorporation.

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INTEGRATING NEW AND OLD HOLOCENE RELATIVE SEA-LEVEL DATA FROM LOUISIANA AND FLORIDA: A DOMINANT ROLE FOR GLACIAL ISOSTATIC ADJUSTMENT

The Holocene relative sea-level (RSL) history of the US Gulf Coast has been a subject of persistent debate for the past 40-50 years, with opposing scenarios that feature continuous submergence vs. one or more Holocene RSL highstands. The implication of this latter scenario is that the role of glacial isostatic adjustment (GIA) in the Gulf of Mexico would be negligible which, among others, has significant implications for the interpretation of tide-gauge records. Here we compare RSL data from Louisiana and Florida to address this problem, focusing particularly on basal-peat data. The goal is to identify possible differential rates of RSL change. We find that RSL data from Florida plot slightly higher than a new data set from the Louisiana Chenier Plain, which in turn plots higher than RSL data from the Mississippi Delta. We attribute the contrast between RSL records from Florida and Louisiana to differences in GIA by means of forebulge collapse, with rates of collapse decreasing with distance from the center of glaciation. Thus, we conclude that RSL records in the Gulf of Mexico are dominated by a GIA signal during the past 7 ka, with a subtle north to south gradient. Superimposed on this, a smaller wavelength flexural signal due to Mississippi Delta sediment loading can be observed in coastal Louisiana. While a eustatic component in all these RSL records cannot be ruled out, it is not likely to be large.

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MARINE SCIENCE INSTRUCTION THROUGH STUDENT CENTERED SERVICE LEARNING PROJECTS

This presentation provides formative findings of a US Department of Education funded project aimed at broadening in-service teacher content knowledge in marine sciences and environmental sustainability through curricular design and K-8 classroom application of service-learning projects. The project’s two major goals are to expand and deepen (a) teacher understanding of marine science content knowledge and related environmental issues and (b) teachers’ repertoire of appropriate and effective instructional strategies for teaching content. Current evaluation of these goals has assessed teacher expansion of content knowledge, environmental attitude and stewardship perspectives with respect to marine science and ecosystems. Forthcoming findings will focus on K-8 student development of content knowledge, environmental attitude and stewardship perspectives with respect to marine science and the impact of service learning projects on classroom environment and local coastal ecosystem health. Findings stem from a June 2011, 2½ day colloquium where 16 K-8 educators actively engaged in hands-on investigations on Little Saint Simons Island, Georgia. Content of these investigations focused on barrier island geological history and ecology, salt marshes, tidal creeks, dunes, maritime forest, and anthropogenic significance/impact. Partners included representatives from NOAA Gray’s Reef National Marine Sanctuary and the Georgia Sea Turtle Center. During this timeframe teachers were given a pre and post assessment of attitudinal instruments related to efficacy and environmental knowledge and stewardship related to marine habitats. Additionally, teachers were given a pre and post assessment of their general marine science content knowledge to evaluate the impact of the colloquium. This presentation shares the initial findings of these assessments along project scope, design and future timeframe.

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ADDRESSING SCIENTIFIC UNCERTAINTIES AND IMPROVING MONITORING EFFICIENCY THROUGH ADVANCED STATISTICAL ANALYSIS OF RECOVER WEST COAST OYSTER DATA

The Comprehensive Everglades Restoration Program (CERP) is being implemented as a means of reinitiating, to the greatest degree possible, natural freshwater flows to the coastal waters of south Florida. The Monitoring and Assessment Plan (MAP) was developed by the Restoration, Coordination and Verification (RECOVER) program as the primary tool to assess the systemwide performance of the CERP. The Eastern Oyster (Crassostrea virginica) has been included as a target species for monitoring because of its wide distribution, historical context, and essential habitat value. Prior to the MAP studies, there was limited understanding of how water management activities relate to the establishment and maintenance of healthy oyster beds in south Florida estuaries. Changes in oyster distribution and abundance are currently monitored in the Northern Estuaries at a variety of sites on both the Atlantic and Gulf of Mexico coasts of south Florida, including the Caloosahatchee River Estuary. The existing database provides a basis for understanding the system under differing water management scenarios, including wet and dry years as well as catastrophic events such as hurricanes. Additional information is needed to assist with daily operations of the existing and future water management structures and to support both system-wide and project level adaptive management. The initial phases of the CRE Oyster monitoring program led to refinement and optimization of the sampling methodology and suggested a close relationship between oyster recruitment, health and survival and water management activities. This project is particularly important for evaluating the oyster hypotheses that underlie the coastal restoration efforts of CERP and provides statistical measures of confidence regarding how well the monitoring plan is addressing uncertainties. CERP Project Teams will incorporate this information into planning future designs and operations.

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AUTOMATED IDENTIFICATION AND ENUMERATION OF BIVALVE LARVAE USING POLARIZED LIGHT

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 spatial and temporal patterns in bivalve larvae distribution in the Choptank River, a tributary of Chesapeake Bay. A high-throughput identification technique will be used to identify bivalve larvae in a large number of samples (>1000) from the sub-estuary. Using the LIHDAT system (built by Scott Gallagher, WHOI), bivalve species will be identified based on birefringent images of color interference patterns with a polarization microscope and a machine learning software program written in MATLAB. We describe the methods for training the software with larvae spawned in the laboratory, as well as the results of a series of experiments used to estimate the accuracy and precision of the LIHDAT system. Preliminary results indicate that four species of bivalves from the Choptank River (Crassostrea virginica, Mulinia lateralis, Tagelus plebeius, Ischiadium recurvum) were distinguished with >95% accuracy. Methods, protocols and application to field samples will be discussed.
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MONITORING THE EFFECTS OF THE COMPREHENSIVE EVERGLADES RESTORATION ON SAV AND WATER QUALITY IN ESTUARIES IN THE NORTHERN ESTUARIES REGION

Natural freshwater discharges from Lake Okeechobee and other areas into the northern estuaries, including the Caloosahatchee River Estuary, San Carlos Bay, Estero Bay on the west coast, and the St. Lucie Estuary, Southern Indian River Lagoon, Loxahatchee River Estuary and Lake Worth Lagoon on the east coast, had historically supported appropriate conditions for the persistence of beds of seagrass and other submerged aquatic vegetation. However, water diversions to meet municipal and agriculture demands as well as the needs for flood control have resulted in increases in the frequency of high and low flows accompanied by greater extremes in salinity and turbidity conditions in many of these estuarine areas. This has contributed to loss of SAV communities. Here we describe a five year program of concurrent monitoring of SAV abundance and water quality undertaken to quantify relationships between changes in freshwater discharges and the subsequent changes in salinity and water quality patterns, as well as to quantify how salinity and water quality patterns impact SAV distribution, community structure, and viability within these systems. Overall, diversity and abundance of SAV within the northern estuaries sites studied here have remained consistent or increased in 2010 compared to the most recent previous monitoring studies in each region. There had been significant recovery from the impacts due to reduced salinities and increased turbidities associated with the effects of hurricanes and other storm events in the 2004-2006 period. Water clarity conditions at the study sites appeared suitable for SAV growth to depths of at least -1m MSL. Inflows were above long-term monthly averages for extended periods during the first six months of 2010, and were below averages during the latter half of 2010 and into 2011. Even with this range of flows, salinities at the SAV monitoring sites remained within suitable ranges for SAV growth.

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EFFECTS OF SALTINESS ON THE HEMOCYTES OF THE GREEN MUSSEL, Perna Viridis, From Florida

The green mussel Perna viridis is a bivalve mollusk native to Asia and was recently introduced to Florida, USA. Since its first observation in 1999 in Tampa Bay, Florida, green mussel population has expanded considerably, to reach the Atlantic coast of Florida, Georgia and South Carolina. Green mussels are known active biofoulers and seem to have the potential to displace local native species such as the Eastern oyster, Crassostrea virginica. Most of currently available studies about the ecology and biology and green mussels were performed in the Indian and Pacific oceans. Very recently, it has been suggested that due to a weak low temperature resistance, green mussels might have already reached the Northern edge of their distribution in USA. However, there is currently an obvious lack of data about the adaptation capacities of P. viridis to environmental conditions in Florida, especially at the physiological and cellular levels. Hemocytes are cells circulating in bivalves’ hemolymph and involved in various physiological functions, including immune defense. In the present work, we analyzed the effects of salinity on the hemocyte profile, phagocytosis and oxidative metabolism. Green mussels were exposed to two different salinities (15% and 35%) during one week and their hemocytes were analyzed at days 0, 3 and 7. Our results showed that a salinity of 15% induced modifications of hemocyte profile, with a decrease of concentration and variations of cellular morphology. However, phagocytosis capacities were not affected by salinity, and the 15% condition only resulted in a transitory oxidative stress at day 3. Therefore, our work suggests that green mussels submitted to low salinity remain immunologically competent and able to adapt their metabolism to such salinity after few days.

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RESTORATION TECHNIQUES FOR THREATENED ACROPORID CORALS IN FLORIDA AND THE CARIBBEAN

Coral reef communities throughout the Western Atlantic and Caribbean have declined sharply, over 80% of hard coral has been lost in the last 30 years. The important structure building acroporid corals (Elkhorn coral, Acropora palmata, and Staghorn coral, Acropora cervicornis) were once the dominant species, but due to multiple and cumulative stressors such as diseases, increased ocean temperatures, reduced herbivore populations, increased nutrient loads, and algal competition, they have faced a 98% decline in population. This rapid decline has caused them to be listed as “threatened” on the U.S. Endangered Species list, and “vulnerable” on the IUCN Red List. In 2009, the American Recovery and Restoration Act provided funding for the NOAA habitat restoration project, Threatened Coral Recovery and Restoration in the Florida Keys and U.S. Virgin Islands to establish genetically diverse groups of coral colonies in order to restore sexual reproduction in Acroporids along Florida and U.S. Virgin islands reefs. This project provided the boost to develop and test new coral restoration techniques through the collaborative effort of many organizations on a regional scale. Here we present a comparison of methods used to propagate A. cervicornis and A. palmata in offshore coral nurseries, and the relative survival after transplantation at 20 experimental restoration sites.

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BALANCING ECOLOGICAL AND MUNICIPAL WATER DEMAND IN A SOUTHEASTERN MASSACHUSETTS COASTAL STREAM

The Town of Scituate in SE Massachusetts obtains drinking water from surface and groundwater sources within the First Herring Brook and its watershed. In the summer the brook often runs dry between the system’s two main impoundments, the Reservoir and Old Oaken Bucket Pond, because flows are controlled by the Scituate’s water department. These low flow conditions have an adverse effect on the ecology of the system. Low flows combined with poorly designed fish ladders have also caused a decline in the herring population for which the brook is named. Given these flow issues, the lack of an active herring run and an interest by the Town in increasing its water withdrawal permit, a condition has been included in Scituate’s permit that they should investigate approaches to maintain adequate flows in the river for ecological benefits and determine the necessary steps to restore anadromous fish passage in the system. A team of stakeholders from non-profit, local, state, and federal agencies has been working to provide the information needed to move forward with restoration of this system and to educate the Town about their options. Efforts have included establishment of flow gauges, evaluation of habitat and water quality in the impoundments, and the use of modeling of the system to provide restoration scenarios based on meeting environmental flow goals and improving passage in the system while maintaining adequate water supply for the town. Scituate is currently working with the NSRWA, Mass. Bays and Mass. Division of Ecological Restoration to control summertime water usage through watering restrictions and to develop operational plans for water releases based upon the WEAP modeling results that will enable the Town to meet minimum flow goals while still maintaining a reliable municipal supply. The next steps will entail evaluating the success of the restrictions and working towards construction of new fish ladders at the impoundments.

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TIDAL CREEK HYDRAULIC GEOMETRY FOR SALT MARSH RESTORATION IN THE UPPER BAY OF FUNDY

Salt marshes around the world have been seriously impacted by human activities and are in need of restoration more than ever in our changing climate. Shifts in environmental regulations, demographic, and economic structure in Nova Scotia have recently produced opportunities to restore these important habitats. However, successful restoration requires a better understanding of the characteristics of these systems than is available in our region at present. This research is intended to improve our understanding of the geometry of tidal creeks in the Bay of Fundy and their relationship to tidal prism using hydraulic geometry. Initially formulated in freshwater systems, hydraulic geometry correlates channel geometry with discharge using a power function and can be applied in tidal scenarios using tidal prism as a surrogate for discharge. The relationship between tidal prism and channel geometry has been well established in many parts of the world, however there is a lack of published exponent values and research on the topic for macro-tidal estuaries. Using ground surveys and high resolution digital terrain data for the Avon and Cornwallis estuaries this study provides exponent values for the region and examines the role of elevation and location in the tidal frame in channel geometry. Furthermore, the accuracy of the relationship is tested using representative creeks for the region and a model for salt marsh restoration in the region is developed.
diversity for macrofauna collected in sediments under U. intestinalis mats was less than half compared to samples collected in bare sediment. By contrast, in San Elijo Lagoon tolerant and opportunistic species of macrofauna drove total macrofaunal abundances that were almost 40 times higher under mats compared to bare sediment. Similarly, diversity in bare sediments was approximately 14% of samples collected under macroalgae. While macroalgae supported higher macrofaunal abundances, omnivores, predatory and suspension feeding macrofauna were excluded from the benthic community in this estuary. This survey demonstrated that macroalgal blooms may drive changes in macrobenthic abundance and community structure in critical habitats across California. Due to the relationship we found between macroalgal biomass and diversity, more research is needed to identify the thresholds of macroalgal abundance that result in positive and negative shifts in benthic community structure.

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SEDIMENT RESUSPENSION BY VERY SMALL WAVES ON AN ESTUARINE INTERTIDAL FLAT

Very small waves (height < 10 cm and period < 2 s) were measured disturbing the seabed fine-sand matrix on a microtidal estuarine intertidal flat and releasing silt into the water column. Resuspension was initiated when ~40% of the maximum wave-orbital speeds in a burst exceeded the critical speed for initiation of sediment motion for the fine-sand matrix. The wave Reynolds number was significantly greater on the ebbing tide compared to on the flooding tide due to changes in intrinsic wave period (i.e., at the surface) and wave height over the tidal cycle. Among these small waves, the wave Reynolds number did not exceed 300,000, and therefore the bed was hydrodynamically smooth. Hence, the wave friction factor was inversely proportional to the wave period, and therefore the wave friction factor was smaller on the ebbing tide compared to on the flooding tide. Accounting for the hysteresis in wave friction factor the effect of approximately collapsing the ebb and flood suspended-sediment concentration data onto the one curve when plotted against the wave-induced skin friction. A model was used to investigate the relative role of large and small waves in doing work on the intertidal flat. At the base of the intertidal flat, waves resuspend sediment for only a small fraction of the inundation time, and the larger waves associated with stronger, infrequent winds dominate resuspension. At the top of the intertidal flat, waves resuspend sediment for about one-third of the inundation time, and very small waves associated with lighter, frequent winds dominate resuspension. Neither the largest nor the most frequently occurring waves dominate resuspension integrated across the profile. The results show that very small waves, which occur more frequently than large waves, can initiate contaminant transport and affect water quality (e.g., clarity) on estuarine intertidal flats.

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APPLICATION OF PROJECT-EFFECT MODELS IN THE 2012 UPDATE OF LOUISIANA’S COMPREHENSIVE MASTER PLAN FOR A SUSTAINABLE COAST

The modeling approach used in the 2012 Update of Louisiana’s Comprehensive Master Plan for a Sustainable Coast is a massive effort consisting of over 60 topical experts assembled to create a suite of project-effect models. The overall approach includes a number of linked models that predict change in the nature of the LA coastal system under both future conditions without restoration and risk reduction projects and as a result of project implementation. The models both input to other models and/or produce outputs which themselves support the estimation of how far projects go toward achieving planning targets. Each model considers important but uncertain factors which drive the dynamics of specific aspects of the system. These uncertainties are used to develop scenarios reflecting the potential range of these external factors 50-years into the future. Thus, for each predicted metric, multiple values reflecting the scenarios are generated for each project evaluated. Simulations are carried out on a coast wide, 50-year planning horizon, with projects assessed by seven models: eco-hydrology, barrier shoreline morphology, wetland morphology, vegetation, upper trophic level, storm surge, and storm damage. Model output is post-processed and fed into a number of ecosystem service models, which along with a set of decision criteria and constraints, is used to inform an MCDA (multi criteria decision analysis) project prioritization application. The LA Office of Coastal Protection and Restoration (OCPR) will use the outcomes of the project prioritization to inform their planning decisions. Funding was provided by OCPR to assemble the team of experts needed to create this modeling suite. This abstract provides only a very general description of each model and, instead focuses more on the larger picture of how the modeling components work together to predict project effects, as well as the direct application of this modeling approach for the 2012 Master Plan.

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MACROALGAL BLOOMS IN CALIFORNIA ESTUARIES MAY DRIVE CHANGES IN MACROFAUNAL ABUNDANCE AND COMMUNITY STRUCTURE FROM THE BOTTOM UP

BLOOMS OF EPHEMERAL MACROALGAE DECREASES THE POTENTIAL FOR WIDESPREAD TROPHIC CASCADES IN CALIFORNIA ESTUARIES. A FIELD SURVEY OF FIVE CALIFORNIA ESTUARIES SHOWED MACROBENTHIC COMMUNITIES, CRITICAL TO FOOD WEB SUPPORT AND NUTRIENT AND BIOGEOCHEMICAL CYCLING, BETWEEN BARE SEDIMENTS AND SEDIMENTS COVERED BY BIOVITALTISAN. MACROALGAL ABUNDANCE AND DIVERSITY VARY BY ESTUARY AND ELEVATED BIODIVERSITY WAS ASSOCIATED WITH REDUCED BENTHIC DIVERSITY. FOR MACROALGAL DIVERSITY, UPPER NEWPORT BAY (UNB) > SAN ELIJO LAGOON (SE) > TOMALES BAY (TB) > HUMBOLDT BAY (HU) > MORRO BAY (MB). MACROALGAL DIVERSITY SHOVED THE OPPOSITE PATTERN: SE < UNB < TB < HU < MB. SEDIMENTS COVERED BY MATS HAD SIGNIFICANTLY LOWER MACROFAUNAL ABUNDANCE AND DIVERSITY COMPARED TO BARE SEDIMENTS FOR MB AND AS COMPARABLE TO SEDIMENTS FROM UNB. MACROALGAL BLOOMS IN ESTUARIES CAUSED HABITAT USE CHANGES AND SIGNALS OF ACCELERATING BENTHIC COMMUNITY CHANGE. THE POTENTIAL FOR MACROALGAL BLOOMS TO AFFECT COMMUNITY SYSTEMS IS CONSIDERED.
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THE NOAA FISHERIES SERVICE HABITAT ASSESSMENT IMPROVEMENT PLAN: AN OVERVIEW OF THE PLAN AND STEPS TAKEN TO IMPROVE MARINE HABITAT SCIENCE

The NOAA Fisheries Service Habitat Assessment Improvement Plan (HAIP) is the first nationally coordinated plan to focus on the marine and estuarine habitats of the nation. It addresses the lack of knowledge regarding the association of marine species and their habitats, which impedes effective fisheries and habitat management, protection, restoration, and stock assessment. National Marine Fisheries Service (NMFS) managers and scientists identified through questionnaires a lack of habitat-specific data, staff, and knowledge of interactions within the ecosystem. The HAIP establishes the framework for NMFS to coordinate habitat research, monitoring, and assessments and to increase support for habitat science. The goals of the HAIP are to: (1) Assist NOAA in developing habitat science; (2) Improve our ability to identify essential fish habitat and habitat areas of particular concern; (3) Provide information needed to assess impacts to essential fish habitat; (4) Reduce habitat-related uncertainty in stock assessments; (5) Facilitate a greater number of stock assessments that explicitly incorporate ecosystem considerations and spatial analyses; (6) Contribute to assessments of ecosystem services; and (7) Contribute to ecosystem-based fishery management, integrated ecosystem assessments, and coastal and marine spatial planning. In accordance with the plan, the Joint National Stock and Habitat Assessment Workshops were held in 2010 to facilitate planning and integration of stock and habitat assessments. Pilot projects funded to accomplish and demonstrate the benefits of habitat assessments include: (1) Modeling Atlantic blue marlin habitat and spatial population dynamics to improve stock assessment studies and benefitting MPA standardization; (2) Incorporating sediment and hydrography data in stock assessments for tilefish and lobster; (3) Relating population abundance of groundfish species to habitats using predictive models and broad-scale seafloor maps.

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OPTIMAL ECOSYSTEM SERVICES PROVIDED THROUGH SHELFISH AQUACULTURE: THE ROLE OF PROPERTY RIGHTS

Cultured and wild bivalves have been an important economic resource in Washington State since the mid-1800s. The economic viability of the industry is due to a number of favorable institutional, economic, and environmental factors, but among them is a successful system of tradable property rights that was put in place by the oystermen of the 19th century, prior to the time that Washington became a state. Today, shellfish aquaculture is also increasingly recognized for the array of ecosystem services provided, including water filtration, nutrient sequestration and denitrification, and habitat. The ecosystem services also have direct human uses with commercial, recreational, subsistence and cultural value. Yet these ecosystem services are typically provided as benefits to the public for which the public does not compensate the tideland owners. Washington State is unique in this property right regime, especially as a substantial portion of the more recent industry producers lease land from the state. In this mixed ownership environment, two policy questions are raised. The first is how to determine the optimal level of ecosystem service provision from the shellfish industry in Washington State. That is, does current industry production meet the demand for ecosystem services in the state, or would the optimal allocation involve an increase in production? Assuming an increase in production is desirable from the public perspective, the second question is which policy mechanisms will be most effective at achieving the needed increase (and no more), given the mixed ownership status of the industry. Both questions will be explored in this paper through a review of the shellfish markets, ecosystem services provided, and economic policy analysis.

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ATLANTIC COAST MARINE ASSESSMENTS: INTEGRATING AND DISTRIBUTING SPATIAL DATA FOR COMPLEX DECISION MAKING IN MARINE SYSTEMS

The Nature Conservancy uses science-based assessments to set conservation priorities and to inform management decisions with the goal of sustaining coastal and marine ecosystems and the human communities that depend on them. The most recently completed assessment, the Northwest Atlantic Marine Ecoregional Assessment, extends from the northern limit of the Gulf of Maine in Canadian waters to Cape Hatteras, North Carolina and extends seaward to the foot of the continental slope. Characteristic habitats and species representing the biodiversity and ecological functions of the Northwest Atlantic region were selected from the following categories: coastal and estuarine habitats, benthic habitats, diadromous fish, demersal fish, small and large pelagic fish, nearshore shellfish, shorebirds and seabirds, cetaceans, and sea turtles. Regional scale data and information were collected and integrated, which provides a greater understanding of the biological diversity of the region and a clearer picture of the current conditions and challenges to their continued persistence. The results were made accessible to partners and the general public through online tools, downloadable reports and data. The Assessment is now being used by the Conservancy, state and federal agencies, and ocean resource stakeholders to inform decisions regarding specific development projects, and to stimulate and guide decisions on conservation priorities and actions. Additionally, we are currently continuing our assessment of the Atlantic Coast by completing similar analyses from North Carolina to the Dry Tortugas and working to fill critical gaps in information in estuaries (e.g. Long Island Sound, Delaware Bay). In this presentation, we will review the techniques used for this assessment, provide examples of the spatial data analyses, and how the information is being used to support permitting decisions and coastal and marine spatial planning initiatives.

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GRAZING IMPACT OF THE INVASIVE CLAM CORBULA AMURENSIS ON THE MICROPLANKTON ASSEMBLAGE OF THE NORTHERN SAN FRANCISCO ESTUARY

Grazing by the overbite clam, Corbula amurensis (formerly known as Potamocorbula) may be the cause of substantial declines in phytoplankton biomass and zooplankton in the San Francisco Estuary (SFE) following its introduction in 1986. While grazing rates have been examined on bacteria, phytoplankton, and copepod nauplii, the consumption of protistan microzooplankton by C. amurensis has not previously been measured. In this study, laboratory feeding experiments revealed that C. amurensis cleared 0.5 L ind-1 h-1 of microzooplankton (ciliates) and 0.2 L ind-1 h-1 of chlorophyll a. Despite the higher clearance rate on microzooplankton, clams obtained more of their carbon from phytoplankton, which dominated the prey assemblage on most dates. When the measured clearance rates are extrapolated to field populations of clams, fractional loss rates (50-90% d-1) exceed the population growth capacity of microzooplankton. Although microzooplankton may not be a major component of the diet of these clams, C. amurensis may further alter food web dynamics through consumption of this important trophic intermediary, thus disrupting this link from bacteria and phytoplankton to higher trophic levels.

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THE DISTRIBUTION OF OVERWINTERING CYSTS OF THE HARMFUL ALGAE AXELRODIUM CATENELLA IN THE SURFACE SEDIMENTS OF PUGET SOUND, WA, IN 2011

There is a long history of contamination of shellfish with paralytic shellfish toxins (PST) in the Puget Sound region, indicated by documented cases of paralytic shellfish poisoning (PSP) from local Native American and First Nations lore and the logs of early fur traders and explorers. PSTs remain a significant threat to seafood safety and human health, with shellfish harvesting closures occurring almost annually. Despite this long history, little is known about the distribution and biology of the causative organism – the harmful dinoflagellate Alexandrium catenella. The Puget Sound Alexandrium Harmful Algal Bloom (PS-AHAB – http://www.tiny.cc/psahab) study is a three year project funded by NOAA/ECOHAB.
designed to understand environmental controls on the benthic (i.e., cyst) and planktonic life stages of A. catenella, and to estimate the effects of climate change on bloom events. This includes mapping the distribution of overwintering cysts, determining environmental and endogenous controls on cyst germination, and assessing the effect of summer transport patterns on connectivity between cyst “seed beds” and shellfish-growing areas. The first year A. catenella cyst distribution mapping survey was completed in winter 2011 consisting of 98 stations throughout Puget Sound, the Strait of Juan de Fuca and the San Juan Islands. Sediment from the upper 0-1 cm was collected using a Crab corer and processed for cyst enumeration, total organic content and grain size. Highest cyst concentrations were found in Bellingham Bay, Birch Bay and Semiahmoo Bay in the north, Port Madison, Liberty Bay and Port Orchard on the west side of the main basin and Quattermar Harbor in central Puget Sound. A preliminary version of this map was shared with local human health officials, marine resource managers, and shellfish growers in spring 2011, as part of the PS-AHAB “just-in-time” information dissemination to stakeholders program.

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DOES IT TAKE A “KICK-START”? ECOLOGICAL RESPONSES OVER TIME TO LARGE AND FAST NITROGEN LOAD REDUCTIONS IN TAMPA BAY, FLORIDA

In Tampa Bay, Florida, the population has quadrupled since 1950. By the late 1970s, eutrophic conditions (phytoplankton and macroalgal blooms, seagrass losses and anoxia) were evident throughout the bay. More than 50% of the seagrasses present in 1950 were lost as a result of insufficient light. Due to local citizen demands for action, the State enacted legislation in 1979 requiring all wastewater treatment plants discharging to Tampa Bay to meet stringent standards (3 mg/l TN concentration) or implement a reclaimed wastewater program. Implementation of these regulatory requirements reduced total nitrogen loading to the bay by approximately 90% from WWTPs between 1978 and 1981. Concentrations of chlorophyll a dropped dramatically, but not for 5 years after nutrient reductions were initiated. In the most urbanized segment of Tampa Bay, the annual average chlorophyll concentrations fell from 37 ug/l in 1980 to 13 ug/l in 1985. Seagrasses responded more slowly to the improved water clarity with expansion starting within the decade following the sharp reduction in nitrogen loadings. Following the nitrogen load reductions initiated in the 1980s and continuing through the present with combined nitrogen reduction efforts of local governments, industries and the public, chlorophyll a concentrations have been maintained at target levels for most years since 1985. Seagrass cover has increased from 8,800 ha in 1982 to 13,300 ha in 2010. A strong and fast “kick-start” point source reduction action, followed by continuous voluntary and regulatory implementation of additional reduction activities, has resulted in progress towards a return from eutrophication to a clear-water seagrass system in Tampa Bay. Would a slower, more gradual load reduction have resulted in similar responses?

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CARBON SEQUESTRATION IN THE SHALLOW COASTAL ZONE

Seagrass meadows are highly productive habitats and provide many important ecosystem services to the coastal zone, including carbon and nutrient sequestration. Organic carbon accumulates in seagrass sediments from both in situ production and sedimentation of water column particles. We evaluated the impact of seagrass restoration on carbon storage in sediments of shallow coastal ecosystems using the large-scale seagrass restoration (~4,000 acres) in the Virginia coastal bays as a model system. Carbon accumulation rates were determined in meadows 4 and 10 years of age (time since restoration was initiated by seeding) and were compared with nearby bare sediments. Sediments of seagrass meadows and bare sites were sampled for organic matter content, percent carbon, and lead 210 for dating. Seagrass shoot density and productivity were also determined. Carbon burial rates are related to seagrass meadow age and shoot density, and are also compared with published carbon accumulation rates from natural meadows in other locations. This is one of the first studies to address the potential importance of seagrass habitat restoration to enhancing carbon sequestration in the coastal zone.

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THE EFFECT OF HYPOSALINITY ON THE PHYSIOLOGY AND SURVIVAL OF HALOPHILA JOHNSONII EISEMAN

To determine the minimum salinity tolerance of Halophila johnsonii Eisenman and the impact of prolonged hyposalinity on its physiology, a mesocosm study was performed. Plants were exposed to either pulsed hyposalinity treatments of 30, 15, 10 and 8, or gradual salinity reductions of two every two days. When salinity was pulsed, the lowest salinity that plants were able to tolerate without exhibiting signs of stress was a salinity of 15. Survivability and maximum quantum yields were high in the control and salinity of 15 treatments but declined in the salinity of 10 and 8 treatments. Leaf osmolality declined with respect to salinity treatment but the difference between leaf and media osmolality remained constant. In contrast, when salinity was gradually reduced, the lowest salinity that plants were able to tolerate without showing signs of stress was a salinity of 6. Survivability remained high from salinities of 30 to 4, and maximum quantum yields remained high from salinities of 30 to 6. Leaf osmolality declined linearly with respect to media osmolality and the difference between leaf and media osmolality remained constant from salinities of 30 to 2. Overall, the results indicate that H. johnsonii is more tolerant of hyposalinity than has previously been reported and that gradually reducing salinity extended its tolerance threshold by around a salinity of 10.

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MOSQUITO BREEDING AREA SOURCE REDUCTION TECHNIQUES EMPLOYED IN RESTORED MOSQUITO IMPoundMENTS

Reconnection and restoration of mosquito control impoundments in Volusia County Florida began in the late 1980s. The restoration consisted of breaching and impoundment dike leveling to salt marsh elevation. Of concern to Volusia County Mosquito Control (VCMC) is the assurance that the positive effects of impoundments on the reduction of salt marsh mosquito populations is not compromised by restoration. These concerns were effectively addressed through the use of proven mosquito breeding area source reduction techniques. These techniques consist of a combination of pothole creation and rotary ditching. Pothole creation allows refuge for fish at times of low water and rotary ditches allow access to breeding areas during flood events. The excellent partnership between VCMC and St. Johns River Water Management District (SJRWMD), the major source of restoration funding, has allowed both organizations to achieve their desired goals. Recent grant funding opportunities have allowed the partnership to expand to include US Fish and Wildlife Service and the Florida Fish and Wildlife Conservation Commission.

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ASSESSING THE IMPORTANCE OF SEAGRASS HABITAT RESTORATION TO CARBON SEQUESTRATION IN THE SHALLOW COASTAL ZONE

Seagrass meadows are highly productive habitats and provide many important ecosystem services to the coastal zone, including carbon and nutrient sequestration. Organic carbon accumulates in seagrass sediments from both in situ production and sedimentation of water column particles. We evaluated the impact of seagrass restoration on carbon storage in sediments of shallow coastal ecosystems using the large-scale seagrass restoration (~4,000 acres) in the Virginia coastal bays as a model system. Carbon accumulation rates were determined in meadows 4 and 10 years of age (time since restoration was initiated by seeding) and were compared with nearby bare sediments. Sediments of seagrass meadows and bare sites were sampled for organic matter content, percent carbon, and lead 210 for dating. Seagrass shoot density and productivity were also determined. Carbon burial rates are related to seagrass meadow age and shoot density, and are also compared with published carbon accumulation rates from natural meadows in other locations. This is one of the first studies to address the potential importance of seagrass habitat restoration in enhancing carbon sequestration in the coastal zone.

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EFFECTS OF WATERSHED URBAN DEVELOPMENT ON WATER QUALITY IN COASTAL BAYOUS, NORTH CENTRAL GULF OF MEXICO

There is little information concerning the impacts of urban development within watersheds on water quality in coastal bayous of the North Central Gulf of Mexico. Three bayous, reflecting a gradient of urban development were monitored during April–December, 2010 in Mississippi. Monthly water samples were collected and analyzed for water temperature, dissolved oxygen or DO, salinity, specific conductance, total suspended solids (TSS), particulate nitrogen and carbon, chlorophyll a, nitrate, nitrite, ammonium, dissolved inorganic nitrogen (DIN), dissolved organic nitrogen (DON), total dissolved nitrogen (TDN), and phosphate from each bayou (n = 5 for Bayou Chico, n = 4 for Bayou Cumbest, and n = 5 for Bayou Heron). Data were log10 transformed and one-way ANOVAs and Tukey’s post hoc tests were conducted to determine the effects of watershed development on water quality conditions. The heavily urbanized bayou (Bayou Chico) had lower DO, salinity, and specific conductance than those of the other two bayous. The pristine bayou (Bayou Heron) had lower TSS than those of the other two bayous. Chlorophyll a was significantly higher in the heavily urbanized bayou than those of the other two bayous. Particulate nitrogen was significantly lower in the pristine bayou than that of the other bayous. The heavily urbanized bayou had significantly higher concentrations of all measured dissolved nitrogen species and phosphate. Watershed urban development may have increased nutrient loads, reduced DO, and stimulated algal growth in the studied bayous.

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CLIMATE CHANGE AND INVASIONS IN COASTAL ECOSYSTEMS

Despite the fact that climate change is likely to profoundly change estuarine ecosystems in coming decades, our understanding of the mechanisms likely bring about that change is quite limited. Among the uncertainties is how rising sea levels, higher water temperatures, increasingly variable watershed inflows, etc. will influence non-native species in comparison to native species. While naive expectations suggest weedy invasive species are more likely to benefit from changing conditions, more complex interactions. The data to date suggests that recruitment and subsequent spread of invasive species may be more strongly influenced by the frequency of events such as El Nino rather than more ordinary anomalies in mean conditions. Data from paired studies of physiological responses typically involving temperature and salinity shows mixed results with respect to performance of native vs. non-native species. Finally, the effects of extreme climatic events such as cyclonic winds, tsunamis, etc. on the spread of non-native species is only now being understood and may increasingly important in the future.

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ADDITION OF ORGANOPHOSPHONATE-P TRIGGERS AN INCREASE IN CYANOBACTERIAL COMMUNITY DOMINANCE IN AN OLGOTROPHIC, P-LIMITED ESTUARY, FLORIDA BAY

The increase in cyanobacterial blooms worldwide has generally been attributed to increased nutrient inputs. In the oligotrophic, P-limited Florida Bay, occasional cyanobacterial blooms have been dominated by members of the genus Synechococcus, often without any observed nutrient inputs. It is well known that cyanobacteria can access organic P while eukaryotic phytoplankton cannot. Our aim was to determine if different chemical forms of P had any effect on the cyanobacterial community in Florida Bay samples. Water samples from 3 sections of the bay were amended with 9 different inorganic and organic P and N species, including phosphate, phosphodiester, inositol P species. Cyanobacterial abundance was assessed using CHL-a concentration and cyanobacteria counts. Changes in cyanobacterial community structure were determined by PCR using primers specific for the cyanobacterial 16S rRNA gene. PCR product were resolved by T-RFLP analysis using 2 restriction enzymes: RsaI and HhaI. T-RF's phylogenetic assignment was performed using a default database generated from the Microbial Community Analysis. Alternatively, three 16S rRNA gene clone libraries were constructed using PCR amplicons obtained from 3 treatments at one site: control, 0.1 mM ADP and 1 mM 2-aminoethylphosphonate (AEP). CHL-a concentrations and cyanobacterial numbers were significantly higher in samples treated with ADP and AEP. Also, an increase in T-RFs peaks belonging to genera Leptolyngbya, Phormidium, and/or Synechococcus were detected. Clone libraries showed an increase in number of DNA sequences related to Lomotroths redekei and Synechococcus in microcosms amended with ADP and AEP, respectively. These preliminary findings suggest that, under P-limitation, growth of cyanobacteria is favored by organophosphonate additions. It is possible that natural or anthropogenic inputs of organic-P compounds may trigger a shift in phytoplankton community structure to that of cyanobacteria and promote bloom formation.

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GENETIC IDENTIFICATION OF A CRYPTIC, NON-NATIVE ALGA (GRACILARIA VERMICULOPHYLLA) AND ASSESSMENT OF NITROGEN SUBSIDIES USING A STABLE ISOTOPE TRACER

The increase in cyanobacterial blooms worldwide has generally been attributed to increased nutrient inputs. In the oligotrophic, P-limited Florida Bay, occasional cyanobacterial blooms have been dominated by members of the genus Synechococcus, often without any observed nutrient inputs. It is well known that cyanobacteria can access organic P while eukaryotic phytoplankton cannot. Our aim was to determine if different chemical forms of P had any effect on the cyanobacterial community in Florida Bay samples. Water samples from 3 sections of the bay were amended with 9 different inorganic and organic P and N species, including phosphate, phosphodiester, inositol P species. Cyanobacterial abundance was assessed using CHL-a concentration and cyanobacteria counts. Changes in cyanobacterial community structure were determined by PCR using primers specific for the cyanobacterial 16S rRNA gene. PCR product were resolved by T-RFLP analysis using 2 restriction enzymes: RsaI and HhaI. T-RF's phylogenetic assignment was performed using a default database generated from the Microbial Community Analysis. Alternatively, three 16S rRNA gene clone libraries were constructed using PCR amplicons obtained from 3 treatments at one site: control, 0.1 mM ADP and 1 mM 2-aminoethylphosphonate (AEP). CHL-a concentrations and cyanobacterial numbers were significantly higher in samples treated with ADP and AEP. Also, an increase in T-RFs peaks belonging to genera Leptolyngbya, Phormidium, and/or Synechococcus were detected. Clone libraries showed an increase in number of DNA sequences related to Lomotroths redekei and Synechococcus in microcosms amended with ADP and AEP, respectively. These preliminary findings suggest that, under P-limitation, growth of cyanobacteria is favored by organophosphonate additions. It is possible that natural or anthropogenic inputs of organic-P compounds may trigger a shift in phytoplankton community structure to that of cyanobacteria and promote bloom formation.

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INVESTIGATING MICROSCOPIC LIFE IN THE OCEAN: AN EXAMPLE OF LEARNING SCIENCE THROUGH RESEARCH

American education policy is placing increased emphasis on science, technology, engineering, and math (STEM) disciplines in effort to improve student achievement and enhance participation in STEM-related fields. The current presidential administration’s “Educate to Innovate” program calls for increasing STEM literacy through, in part, collaborations among the science and education communities with a primary goal of cultivating a new generation of critical thinkers and problem solvers. Our Learning Science through Research program aims to address this goal by linking classroom curricula with hands-on student learning activities, which are based on current research programs at the University of Maryland Center for Environmental Science Horn Point Laboratory (HPL). As part of this program, students from local middle and high schools visit the lab for one-day field trips during which they address a research question associated with the work of an HPL scientist. The topics of these activities vary; however we emphasize in all programs the processes of inquiry and investigation in order to promote critical thinking. One particularly successful student learning activity focuses on microscopic life in the ocean. During the activity, students view a presentation by an HPL faculty member specializing in microbial ecology, and then are challenged to detect and identify microscopic organisms living in our local tidal river. They design and build plankton nets, collect plankton samples, use inference to identify functional groups present in their samples, and assemble a microscopic food web based on their findings. We supply students with materials and tools, but the investigation is largely student-driven. In this way, students strengthen their understanding of STEM content taught in science class as well as develop their ability to find creative and innovative ways to solve problems.

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UNEXPECTED RESURGENCE OF A SUBMERGED PLANT BED IN CHESAPEAKE BAY: ANALYSIS OF TIME-SERIES DATA

Despite recent declines in submersed aquatic vegetation (SAV) populations in much of Chesapeake Bay, plant abundance in one large (5000 ha) shallow SAV bed located in upper Chesapeake Bay (Susquehanna Flats) has experienced a dramatic resurgence over the last decade. Although elevated nutrient inputs have been shown to preclude SAV survival in many estuaries worldwide, this SAV bed is thriving despite high nutrient concentrations at a...
Hadley, N. assesses current and historical trends in eutrophication states as result of human activities. Term monitoring programs in critically impacted ecosystems along coastal areas in Mexico (Carretas-Pereyra lagoons). Our analysis underscores the need to develop and implement long-term simulation models and to improve site-selection protocols for dependable SAV restoration.

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SHORT-TERM VARIABILITY OF MEXICOAN COASTAL LAGOONS, CAN THEY TELL US SOMETHING ABOUT LONG TERM VARIABILITY?

The impact of human activities in Mexico coastal zone is increasing at an accelerated rate particularly during the last two decades as result of tourist development, population growth and industrial activities. These economic activities in turn cause an increase in nutrient loading and diversion of freshwater to meet human water demands. However, it is unknown what would be the response of these environments to both increasing nutrient inputs or alterations of the hydrological regime. One of the sources for this uncertainty is the lack of spatial and temporal long-term records of hydrological and biogeochemical processes that can help make distinctions between the relative role of natural system variability and human impacts. We evaluated hydrological properties and biogeochemical variables and its influence on phytoplankton biomass in several Mexican coastal lagoons located both in the Pacific and Gulf of Mexico coasts to determine the contribution of natural and human disturbances. There are major differences in hydrologic and geomorphic properties among the coastal systems included in this study; with lagoons influenced by high freshwater discharge and permanently connected to coastal waters (Alvarado lagoon), to systems hydrologically regulated by epiperal incis (Coyusca and Grande lagoons) resulting in increasing water residence time and phytoplankton biomass and productivity. Moreover, other systems show a strong seasonal freshwater discharge (both wet and dry seasons), with either permanent or ephemeral communication with the sea (Chantuto-Panazaola and Carretas-Pereyta lagoons). Our analysis underscores the need to develop and implement long-term monitoring programs in critically impacted ecosystems along coastal areas in Mexico to assess current and historical trends in eutrophication states as result of human activities.

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DEVELOPING VOLUNTEER-FRIENDLY NEKTON SAMPLING METHODS FOR THE ASSESSMENT OF ECOLOGICAL FUNCTION OF RESTORED OYSTER REEFS

A widely touted benefit of oyster restoration is establishment of quality habitat for fish and motile invertebrates, but this is rarely verified after reef construction. The South Carolina Oyster Restoration and Enhancement (SCORE) community restoration program has established multiple restoration sites over a ten year period. This program combines education and science in order to promote oyster restoration efforts. We have evaluated a suite of restoration metrics at SCORE sites as indicators of restoration success but these metrics do not include any parameters for habitat use by finfish and larger motile invertebrates. In 2009 we utilized high-school and college student volunteers to construct and test a suite of fishing gear on intertidal restored oyster reefs in order to develop nekton sampling methods suitable for implementation by volunteers. Seven gear types were tested with up to 41 trials per gear type. A total of 64 different taxa were identified in these sampling trials, with different gear types collecting an average of 0.3 to 1416 specimens per fishing trial. Gear were deployed on oyster reefs and adjacent shorelines lacking structure, providing preliminary data on faunal diversity on and around these intertidal habitats. Experimental gillnets and straight seines were the most volunteer-friendly of the tested methods. These have been used in additional sampling with volunteers on two sites in Charleston Harbor and will be utilized to sample existing and future SCORE sites and natural oyster reefs as we strive to broaden our suite of metrics for evaluating restoration success.

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NUMERIC NUTRIENT CRITERIA FOR ESTUARIES AND THEIR WATERSHEDS

Numeric nutrient criteria are currently being developed for many estuaries and their watersheds throughout the U.S., representing a major evolution in implementation of regulatory approaches to water quality management. This special session on development of criteria is bringing together speakers from regulatory agencies, private consulting firms, and universities from all three coasts of the U.S. All are engaged in some way in criteria development and related regulatory management activity. This presentation will help frame

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UTILIZING DEPTH OF COLONIZATION OF SEAGRASSES TO DEVELOP NUMERIC WATER QUALITY CRITERIA FOR FLORIDA ESTUARIES

U.S. EPA is working with state and local partners in Florida to develop numeric water quality criteria to protect estuaries from nutrient pollution. Similar to other nutrient management programs in Florida, EPA is considering status of seagrass habitats as an indicator of biological integrity, with depth of colonization of seagrasses used to relate potential seagrass extent to water quality requirements (especially water clarity). We developed and validated an automated methodology for evaluating depth of colonization and applied it to generate 228 estimates of seagrass colonization depth for coverage years spanning 67 years (1940-2007) in a total of 100 segments within 19 estuarine and coastal areas in Florida. A validation test showed that two parameters that were computed, Zc50 and ZcMax, approximated the average and 95th percentile depth at the deep-water margin of seagrass beds. Zc50 was estimated separately for continuous seagrass vs. all seagrass. Average values for Zc50 as well as long-term trends were evaluated for the entire state, illustrating a decline on average from early years (e.g., 1940-1953) to a middle period (1982-1999) and a variable degree of recovery since 2000. The largest decrease in Zc50 occurred in Florida panhandle estuaries. Extensive water quality data compiled in the Florida DEP’s Impaired Waters Rule database was evaluated to characterize Secchi depth, CDOM, TSS, and chlorophyll-a in relation to depth of colonization estimates. Zc50 was significantly related to water clarity averaged during the leading 3-year period inclusive of the coverage year. Relationships within estuaries were stronger than those across estuaries. Management programs addressing nutrient enrichment in several Florida estuaries have established seagrass recovery goals based on the highest documented seagrass extent. We evaluate the potential to apply a similar approach to other Florida estuaries.

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LOCATION, LOCATION, LOCATION: MANAGEMENT USES OF MARINE BENTHIC BIOGEOGRAPHICAL INFORMATION IN COASTAL WATERS OF THE NORTHEASTERN USA

Ecosystem-based management practices, along with coastal and marine spatial planning, have been adopted as foundational principles for ocean management in the United States. The success of these practices depends in large measure on a solid foundation of biogeo graphical information at spatial scales ranging from regional oceans to individual estuaries and bays. Marine biogeographical studies have become more sophisticated with the advent of satellite imagery, large-scale monitoring programs, ocean observation systems, benthic habitat mapping, landscape ecology, geographic information systems, integrated databases, ecoinformatics, and ecological modeling. Biogeographical data support ecosystem-based management, make coastal and marine spatial planning ecologically meaningful, and form the basis for marine biodiversity conservation. Examples from the Canadian border to Delaware Bay illustrate how biogeographical information can be used in management of nearshore waters. Seven biogeographical sub-regions—five based on latitude and two on salinity—provide a regional context for management actions based on individual estuaries or bays. Biogeographical data can help manage water bodies such as Long Island Sound that split political jurisdictions. Indentifying similar low salinity areas in the southern Gulf of Maine may help conserve biodiversity. The focus is on benthic communities, which are sensitive to many stresses from human activities and widely used in monitoring programs.

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NUMERIC NUTRIENT CRITERIA FOR ESTUARIES AND THEIR WATERSHEDS

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SEAGRASS MAPPING IS MANAGEMENT OF THE INDIAN RIVER LAGOON, FL

Seagrass is regarded as critical habitat in the Indian River Lagoon (IRL) by several state and federal resource restoration programs. These programs recognize seagrass mapping as an essential monitoring-management stratagem. Mapping has been done every 2-3 years since 1986 (plus 1943), with 2011 mapping currently underway. Seagrass mapping technologies have evolved with advancements in image acquisition and processing, and improved photo-interpretation software. The uses for seagrass maps have also evolved. In the early years, the focus was on simple trend analysis; for example, comparing 1943 seagrass acreage with subsequent years to evaluate losses and gains. Such trend analysis continues, but mapping is now being applied toward more specialized spatial analyses as in the use of union coverages of multiple mapping years. Union coverages of 1943 through 1999 mapping years were used to establish management targets for seagrass depth-limits and associated acreages. The depth-limit targets were subsequently used as the basis for developing total maximum daily loads (TMDLs) for nutrients. Consequently, assessment of management practices, TMDL seagrass targets, as well as the IRL’s response to episodic events (e.g., tropical storms) will be dependent on future seagrass mapping.

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SEAGRASSES AS INDICATORS OF ECOSYSTEM CHANGE IN SOUTH FLORIDA ESTUARIES

Seagrasses form long-lived, ecologically-important communities near the land/sea interface in many coastal regions. Seagrasses were chosen as a central performance measure for assessing effects of the Comprehensive Everglades Restoration Plan (CERP) because they integrate net changes in water quality parameters that tend to exhibit rapid and wide fluctuations when measured directly and are sensitive indicators of changing water quality conditions. However, seagrass distribution and abundance can be inherently variable making it difficult to evaluate status and trends over short time periods. The Periods Habitat Assessment Program (FHAP) has been providing detailed information on the distribution, abundance, and species composition of Florida Bay seagrass communities since 1995. Analysis of long-term data (1995 to 2010) revealed patterns of seagrass change in western Florida Bay that reflect recovery and secondary succession following the widespread die-off of Thalassia testudinum in the late 1980s and subsequent persistent turbidity from algal blooms and sediment resuspension from the early to mid-1990s. However, analysis of shorter-term or long-interval data for these basins suggested increases, decreases, or no change in the status and trends of the seagrass communities in the bay, depending on what time interval was analyzed. Thus, to establish ecosystem condition or to interpret landscape-scale changes that may occur in seagrass ecosystems in response to management actions or environmental perturbations requires decadal-scale monitoring.

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IT’S A SMALL WORLD: MICROBIAL ECOLOGY, ECOSYSTEM FUNCTION AND CHANGE IN AQUATIC ENVIRONMENTS

Over the last decades, research activities have provided a wealth of knowledge on the metabolic role of microorganisms in coastal and estuarine environments and on the structure of microbial populations. In recent years, the microbial community has begun to assess how environmental change, largely resulting from human activities, has altered metabolic function and community structure in a variety of habitats. This presentation will discuss studies which place microbial systems in context with eutrophication in the aquatic environment. Examples will be provided of how eutrophication has altered the flow of carbon in the estuarine environment and resulted in result in dysfunction in the microbial loop. Disruptions in the microbial loop have potential to limit the flow of carbon up aquatic food webs, and accelerate water column oxygen demand. In addition, works which document the result of change on microbial communities in the form of altered flux of green house gases, disruptions in nutrient cycling and internal changes to microplankton food webs in a variety of aquatic environments will be discussed. Such works highlight the value of understanding microbial interactions with the changing environment, as such interactions may impact whole ecosystems.
PATCH DYNAMICS AND THE ROLE OF EDGE AND INTERIOR FOR SOUTHEASTERN NORTH CAROLINA OYSTER REEF COMMUNITIES

A common theme for edge and interior dynamics and edge effects is the necessity to critically evaluate and understand the processes and the impacts edge has on a species, species interactions, organism’s dispersal, and community composition. However, the majority of these issues for reefs comprised of the eastern oyster (Crassostrea virginica) have never directly been addressed on a large scale. The eastern oyster is an important ecological and economic estuarine organism. Ecologically, oysters are important due to their filtering capacities which can maintain or increase water quality. Oysters are ecosystem engineers because they provide structure and habitat for many invertebrates and fish. Despite all of the ecological services oysters provide, populations are in decline, which creates habitat fragmentation and therefore decreases the amount of interior habitat. Even with the ecological and economic importance of this species, few studies have directly addressed broad scale habitat patches with the role of edge and interior habitats. The goal of this study was to determine edge and interior dynamics on oyster reefs for oysters, benthic macrofauna and ichthyofauna. Specifically, we examined three different sizes of intertidal oyster reef patches; small (2-3 m), medium (5-8 m), and large (>10 m) distances from the edge to the center. This was done for both patch reefs and reefs fringing Spartina alterniflora marsh.

Densities and size demographics for oysters were sampled one meter away from the edge of the reef, three meters away from the edge for the medium and large reefs only, and the center of the reef for all sizes. Abundance, community composition, and species diversities were determined at the same distances for benthic macrofauna and fish. The role of patch size and the distance from edge to interior elicits a response in oysters, benthic macrofauna, and fish communities.

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MICROTOPOGRAPHY MEDIATES COMPETITIVE INTERACTIONS BETWEEN AN INTRODUCED SEAGRASS AND ITS NATIVE CONGEREN

The asian seagrass Zostera japonica was likely introduced to the Pacific Coast of North America near the end of the 19th century, and now ranges from British Columbia to Humboldt Bay, California. In its introduced range, Z. japonica sometimes co-occurs with native Z. marina in a patch mosaic in conjunction with intertidal microtopography. At such sites, Z. marina often inhibits depressions that retain water through a low tide, and Z. japonica often inhabits mounds that are fully exposed during low tides. Elevation surveys indicated that an index of topographic position is a significant predictor of species presence at one such in Padilla Bay, WA. To elucidate the roles of abiotic limitations and biotic interactions in this pattern, we experimentally transplanted each species, in monospecific and mixed patches, to intertidal mounds and pools. In the first year of transplantation, Z. japonica shoot densities were depressed in the presence of Z. marina, regardless of topographic position and Z. marina shoot densities were depressed on mounds regardless of Z. japonica presence. Shoot growth and morphological responses were less consistent than shoot density in the first year. These results suggest that Z. japonica is competitively excluded from pools and Z. marina is physiologically restricted from mounds. Further experiments are under way to assess the possible density dependence of Z. japonica’s effect on Z. marina.

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A COMPARISON OF RESTORED OYSTER REEF SUCCESS BASED UPON MEASURED HYDRODYNAMICS

A field study within the northern section of Canaveral National Seashore, FL was initiated 1) to characterize the hydrodynamics of the area, and 2) to correlate flow with oyster reef health; the preceding tasks are used to promote an ongoing oyster reef restoration effort within Mosquito Lagoon by optimizing the geographical and key environmental factors. The observational campaign included installation of a weather station and deployments of submerged pressure sensors during a seven week period under spring-neap tidal conditions to quantify the microtidal flows and winds in the area. Vessel mounted Acoustic Doppler Profiler (ADP) surveys also were conducted at strategic cross-sections over a semi-diurnal period. Analysis of the free surface and current data will extract contributing tidal constituents and allow determination of residence times for areas of interest adjacent to well-performing and poorly performing restored oyster reefs as determined by planview oyster reef area.

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WAVE AND TIDALLY DRIVEN FLOWS WITHIN ZOSTERA MARINA SEagrASS BEDS AND THEIR IMPACT ON SedIMENT SUSPENSION

Seagrass beds alter their hydrodynamic environment by inducing drag on the flow, thereby attenuating wave energy and near bottom currents. This alters the turbulent structure and shear stresses within and around the seagrass bed that are responsible for the suspension and deposition of sediment. To quantify these interactions, velocity, pressure, and sediment measurements were obtained across a density gradient of a Zostera marina seagrass bed within a shallow coastal bay (1-2 m depth). Z. marina beds were found to reduce near-bottom mean velocities by 70-90%, while wave heights were reduced 45-70% compared to an adjacent unvegetated region. Wave orbital velocities within the seagrass bed were reduced by 20% compared to flow above the bed, primarily acting as a low-pass filter by removing high frequency wave motion. However, relatively little reduction in wave energy occurred at lower wave frequencies suggesting that longer period waves were able to effectively penetrate the seagrass meadow. Average bottom shear stresses were found to be 0.17±0.08 N m⁻² at the unvegetated region, significantly larger than the critical stress threshold necessary for sediment entainment of 0.04 N m⁻², while stresses remained below the critical value 90% of the time in the seagrass meadows. Expansion of Z. marina within the coastal bay has thus altered the dynamics of the seafloor from an erosional environment to one that promotes deposition of suspended sediment, enhancing light penetration throughout the water column and creating a positive feedback for seagrass growth.

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SEA LEVEL RISE AND CLIMATE CHANGE EFFECTS ON MARSH PLANTS SPARTINA ALTERNIFLORA AND TYPHA ANGUSTIFOLIA USING MESocosMS

A four month experiment using greenhouse mesocosms was conducted to analyze the effect of sea level rise and climate change on salt marsh plants Spartina alterniflora (cordgrass) and Typha angustifolia (narrow-leaved cattail). Our goal was to examine the effects of three different sea level rise scenarios on flooding frequency, foraging and growth of the marsh plants. Pots containing the plants were placed across three 600L tanks with treatments of ambient air, storm, or drought conditions. Each shelf in each tank had Spartina and Typha plants in individual 6in diameter pots (n=3) containing a homogeneous soil matrix. The tanks received different levels of freshwater input which compared the climate change effect of infrequent, severe rain storms to ambient rain or drought conditions. The plants in the ambient rain tank experienced a daily 3.25mm rise in freshwater, the storm tank a biweekly freshwater level rise of 10cm, and the drought tank never received freshwater. All tanks received seawater on a twice daily tidal cycle. The pots were situated on shelves at three different levels to receive three levels of tidal flooding: low, medium, and high. Above ground plant growth was measured once monthly for the duration of the experiment. We observed a low survival rate for all Typha exposed to high levels of flooding in all tanks, as well as drought conditions, while Typha that experienced both freshwater input and low tidal flooding thrived. Spartina plants proved resilient in all conditions. At the conclusion of the study belowground biomass was calculated and showed Spartina plants to have an extensive root structure across all treatments, while Typha had minimal root mass. From the results of this pilot study, we will conduct further experiments that reexamine sea level rise and additional climate change effects on marsh plants.

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CONTRASTING EFFECTS OF SIZE-SELECTIVE FISHING ON ATLANTIC COD AND AMERICAN LOBSTER - A REFUGE IS CRITICAL

The potential for size-selective fishing to negatively affect the population demographics of fishes and invertebrates has been recognized for over a century yet this phenomenon has
received remarkably little empirical study. Two case studies from the southern Gulf of St. Lawrence were presented and the effects contrasted. (1) Changes in fishing technology and increased fishing efficiency since the early 1980s had the effect of removing the size refuge and imposing unsustainable harvest rates for Atlantic cod. The fishery removed fast-growing individuals of each cohort at a much faster rate than slow-growth individuals for > 7 years. Over 4-5 generations of very high exploitation, this resulted in a genetically-dwarped population and an upper size limit. This slot fishery allows the lobster to grow through the fishing window after only 3 or 4 molts. The surviving lobster may then live to reproduce for 30 to 40 additional years. Thus, large fecund individuals continue to be important contributors to lobster larval production unlike cod where medium to large individuals were effectively but eliminated several (fish) generations ago.

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AN EXPLORATION OF METABOLISM IN THE CHESAPEAKE BAY USING THE METABOLIC THEORY OF ECOLOGY

Metabolism is the basis of life and our understanding of individual organismal respiration and primary production is inherently linked to whole-system metabolism. The scaling of these rates and the thermodynamic dependency of metabolic reactions on temperature can tell us much about the relative autotrophic or heterotrophic status of an estuary, and how this metabolic balance may change with rising temperatures in the face of climate change. Using the Metabolic Theory of Ecology (MTE) we have been able to predict that a 4 degree Celsius change in water temperature used for climate change predictions could result in a 20% increase in net primary production and a 43% increase in heterotrophic metabolism, thereby decreasing P-R ratios. However, testing these predictions requires either carefully controlled experiments or datasets that include relevant metabolic variables across time and space that can substitute for temperature gradients created in the laboratory. Here we present the results of an effort to use the Chesapeake Bay long-term monitoring dataset to test MTE predictions and consider implications for future climate scenarios. An investigation of the emergent role of biodiversity in patterns of primary production and respiration is also presented to provoke questions regarding the role of community composition in optimizing net metabolism.

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THE PURPOSE OF WELL-BEING METRICS FOR EVALUATING ECO SYSTEM SERVICES

The natural environment provides a multitude of goods and services that benefit people. These benefits are realized not only in the economic value of ecosystems, but in their intrinsic value as well. This ecosystem-human relationship is clearly evident in communities that reside within coastal watersheds. Although counties in these watersheds represent less than one-third of the U.S. land area, greater than 50% of the total population live in coastal watersheds and these areas contribute more than half of the Nation’s economic output. For these reasons, the value of coastal ecosystems is commonly quantified in terms of economics. However, economic drivers alone are not enough to account for the rapid population growth exhibited in coastal communities. To better understand the random benefits that humans derive from healthy and productive ecosystems, holistic approaches are needed to evaluate the qualitative linkages between ecosystem services and constituents of sustainable human well-being. Building upon existing well-being measures developed for economic and social accountability, we have developed an approach for linking ecosystem services to a core set of well-being domains. By evaluating these qualitative and quantitative linkages, we can demonstrate the utility of using a quantifiable measure of well-being that incorporates ecosystem services to enhance community-based alternative-scenario planning and encourage more sustainable community practices and governance.

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USEPA - GULF ECOLOGY DIVISION IS “ADAPTING TO CHANGE”

The theme of CERP 2011 reflects a growing realization that human societies are an integral component of ecosystems and the dynamics of these societies and ecosystems are interactive - their futures are interdependent. The USEPA Gulf Ecology Division’s (USEPA-GED) mission is to conduct ecological effects research to assess sustainability of estuarine and coastal systems, determine cause(s) of affected and declining systems, predict future risks to population and ecosystems, and support development of criteria to protect coastal systems of the Gulf of Mexico and the southeastern United States. Now more than ever, USEPA is focusing on a number of important mission areas that match well with the theme for this year’s CERP conference. This poster: (1) describes some of EPA’s latest priority mission areas on healthy and sustainable communities, and safe and sustainable water resources.
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CASE STUDIES AND CAVETS: MICROBIAL SOURCE TRACKING IN COASTAL WATERS

Fecal indicator bacteria (FIB) used to assess the safety of coastal waters, such as enterococci and fecal coliforms, are shed in animal and human feces; therefore, they provide no information about the source of fecal contamination in water. This drawback has proven problematic for assessment of human health risk, and for efforts to mitigate and remediate contamination of environmental waters. Microbial source tracking (MST) encompasses a group of methodologies that identify the sources of fecal pollution in water via methods that range from low-tech (e.g. careful, boots-on-the-ground surveying of the watershed) to high-tech (e.g. quantitative PCR targeting genes of microorganisms that are restricted to the gastrointestinal tract/feaces of a particular host type). This session, which has immediate application to recreational water quality and total maximum daily load applications, will provide information on various MST methods and their use in investigating sources of fecal contamination to coastal waters. Speakers at the session, which include representatives from federal agencies, universities, and nonprofit organizations, will cover ongoing research as well as established methods.

MICROBIAL SOURCE TRACKING: FECAL POLLUTION SOURCES IN COASTAL WATERS

The microbial safety of water, drinking water, recreational water, and wastewater effluent is assessed, worldwide, by measuring the level of fecal indicator bacteria (FIB) such as Escherichia coli and enterococci. Surrogates, such as FIB, are used as opposed to direct pathogen measures due to the variety of possible pathogens, their rare and patchy distribution, and the lack of resources that are required for pathogen detection. The advantage of FIB measures is that these bacteria are widely distributed and relatively concentrated in the feces of vertebrate hosts, making them, in general, conservative proxies for pathogens; however, traditional FIB measures provide no information about the source of fecal contamination in water. This drawback has proven problematic for assessment of human health risk, and for efforts to mitigate and remediate contamination of environmental waters. Microbial source tracking (MST) encompasses a group of methodologies that identify the sources of fecal pollution in water via methods that range from low-tech (e.g. careful, boots-on-the-ground surveying of the watershed) to high-tech (e.g. quantitative PCR targeting genes of microorganisms that are restricted to the gastrointestinal tract/feaces of a particular host type). This session, which has immediate application to recreational water quality and total maximum daily load applications, will provide information on various MST methods and their use in investigating sources of fecal contamination to coastal waters. Speakers at the session, which include representatives from federal agencies, universities, and nonprofit organizations, will cover ongoing research as well as established methods.

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CASE STUDIES AND CAVETS: MICROBIAL SOURCE TRACKING IN COASTAL WATERS

Fecal indicator bacteria (FIB) used to assess the safety of coastal waters, such as enterococci and fecal coliforms, are shed in animal and human feces; therefore, they provide no information about fecal contamination sources. Such information is essential for risk assessment and remediation of polluted (impaired) waters. Microbial source tracking (MST) detects and in some cases quantifies genes from microorganisms that are strongly host-associated, i.e. that are largely confined to a particular host species or group. This presentation will focus on the necessity of rigorously determining the performance of MST methods in the lab and field, and will present several case studies conducted in coastal waters. We examined the performance characteristics of qPCR methods for two human-associated markers (human polyomaviruses and Bacteroides IHD183), including sensitivity, specificity, and detection limit, and compared results of qPCR methods for Escherichia coli and Enterococcus to standard membrane filtration. The general Bacteroides marker was also measured by qPCR. Each qPCR method yielded quantitative performance, with r-squared values for standard curves between 0.98 and 0.99. Efficiency ranged from 81.45 (HPyVs) to 98.75% (E. coli). HF183 had the lower sample limit of detection of the human markers with respect to sewage, i.e. sewage could be diluted further before losing the signal; however, HPyVs displayed greater specificity to human waste (100%). qPCR-based measurements of enterococci and E. coli in ambient waters were well-correlated with culture results. MST and qPCR promise to be powerful tools in the arsenal of scientists, managers and regulators concerned with water quality; however, like all research and monitoring tools, their performance characteristics and limitations must be understood for accurate interpretation of results.

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GULF OF MEXICO SEA GRANT - PERSPECTIVES ON IMPACTS AND FUTURE NEEDS RELATED TO THE DWH OIL SPILL

The Deepwater Horizon oil well blow-out in spring 2010 had wide-ranging impacts to the Gulf of Mexico ecology and economy and to the health and welfare of Gulf coast residents. In the northern Gulf, large regions of sensitive wetland habitat were severely impacted by oil; large regions of the Gulf were closed for months to fishing; and the economies of coastal communities that depend on fishing, tourism and other water-related uses were heavily impacted. While Louisiana suffered the greatest ecological impacts, the economic blow was most strongly felt in Florida, where tourism and fisheries were hard hit by a false perception of oil impacts that did not occur. Communities still are recovering around the Gulf in 2011. The four Sea Grant Programs of the Gulf of Mexico (FL, LS, MS-AL, and TX) quickly responded to the needs of coastal businesses, people and communities during the disaster.
DYE TRACER EXPERIMENT IN A GEORGIA TIDAL MARSH SYSTEM

A conservative dye tracer experiment was performed in a Georgia tidal creek marsh system to provide a dataset of the concentration/time dye distributions at several selected locations for evaluation of numerical simulations and flushing characteristics. Thirty-two kilograms of Rhodamine WT were released as a lime source on an incoming tide about 2 hours past low water near the model boundary. A combination of immediately available sample collection techniques were deployed to sample the dye distribution in the marsh system. Automated samplers and in-situ fluorometers were deployed for long-period sampling (up to 2 weeks). To characterize the dye profile near the release location, dip collection was deemed the most expedient method. The automated and dip collection samples required the laboratory measurement of the dye concentrations. All samples have been analyzed, about 600 laboratory determinations from automated and dip collection are undergoing final review. An overall review of the dye experiment will be presented.

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WACCAMAW RIVER VOLUNTEER WATER QUALITY MONITORING PROGRAM: INTEGRATING NEEDS OF STATE AND LOCAL STAKEHOLDERS

South Carolina’s coast is one of the fastest growing regions in the United States, prompting concern for the potential effects of coastal development on local waterways. The Waccamaw River is a relatively pristine black water river stretching from Lake Waccamaw in southeast North Carolina through Northeast South Carolina to its outlet at Winyah Bay near Georgetown. In June 2006 teams of trained volunteers commenced bimonthly monitoring of the Waccamaw River. Program goals were: (1) address NPDES Phase II program measures for public education and involvement; (2) monitor long term trends; (3) illicit discharge detection; and (4) improvements from implementation of the Small Municipal Separate Storm Sewer Systems (SMS4’s) stormwater program. A cornerstone of this program has been creating opportunities for community involvement, from project planning to long-term site monitoring. This effort, supported by federal agencies, local municipalities, Coastal Carolina University and an environmental nonprofit, has pooled resources and knowledge to train and equip citizen scientists to monitor their watershed. Results from these monitoring efforts will be presented, including training protocols, standard operating procedures, quality control and data dissemination (ref: www.coastal.edu/wqa/vm/wr). This assessment includes comparison to established water quality standards (WQS), including using the 75th and 90th percentiles as guidelines to determine uncharacteristic conditions and emphasizes the importance of considering system type (typology) and eutrophication conditions in assessing state and regional water quality standards.

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NUTRIENT BUDGETS OF A SHALLOW TIDAL ESTUARY IMPACTED BY NITROGEN-ENRICHED GROUNDWATER FLOWS

Human activities have resulted in a dramatic increase in the nitrogen loading to West Falmouth Harbor, a shallow, macrophyte-dominated estuary located on Cape Cod, Massachusetts, but these activities have not significantly altered the supply of phosphorus. We have recently completed a multi-year study looking at the sources of both nitrogen and phosphorus to this system, and have constructed budgets for both of these nutrients. These budgets include detailed estimates of the dominant fluxes: submarine groundwater discharge and tidal exchange with adjacent Buzzards Bay. This allows us to assess how the ratio of these two major nutrients has been altered by this unbalanced anthropogenic loading and to predict how this is affecting primary productivity and biogeochemical cycling in the estuary. Data show that the estuary is retaining most of the terrestrial nitrogen load during months with higher productivity and assimilation, and that phosphorus input from tidal exchange is sufficient to retain nitrogen limiting conditions during the summer months despite high nitrogen loading. This provides us with a context for examining rates of biogeochemical processes within the estuary and to project how they will be affected by changes in future loading.

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ANALYSIS OF SPATIAL AND TEMPORAL VARIATIONS IN BEACH AND NEAR-SHORE BATHYMETRY PROFILES AND SEDIMENT GRAIN SIZE DISTRIBUTION OF SELECTED BEACHES IN BREvard COUNTY AFTER BEACH NOURISHMENT IN 2010

Dredge and fill operations were performed in the North and South Reaches of Brevard County between January and April of 2010. The current U.S. Army Corps of Engineers requirement for annual surveys of beach nourishment projects is not necessarily sufficient to capture the response of beaches as they transition from the fill template back to a natural equilibrium profile. Instrumentation was developed to measure the littoral wave environment and perform near-shore bathymetric surveys at significantly lower costs than traditional methods. Beach and near-shore bathymetric surveys were performed monthly (or as weather allowed) to document the evolution of the beach and littoral environment before and after nourishment. Data from the wave gages and surveys was utilized to analyze the evolution of the nearshore bathymetry and wave climate of selected beaches within and outside the nourishment projects. Sediment samples were also collected monthly at each site to analyze the redistribution of sediment after nourishment. The results from these samples will be presented along with an analysis of the beach evolution process. The findings from this research will provide valuable insight into the coastal response of beach nourishment projects and provide a new data set for use by other coastal researchers.

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NITRIFICATION, DENITRIFICATION, AND ANAMMox IN THE CENTRAL BASIN OF LAKE ERIE

We studied N-dynamic processes in the water column and surficial sediments of the central basin of Lake Erie in 2009 and 2010. The central basin hypolimnion is shallow and becomes hypoxic in mid-July through mid-September. Nitrifying Bacteria and Archaea were distributed throughout the water column and in the sediments. Although 95% of the prokaryotes in the water column and sediments were bacteria, the abundance of ammonium oxidizing archaea (AOA) generally exceeded that of ammonium oxidizing bacteria (AOB) in the water column. AOA were always more abundant than AOB in the sediments, and the AOA:AOB ratio was always greatest in the sediments. The abundance and distribution of AOA and AOB throughout the central basin was patchy, did not exhibit significant longitudinal changes in distribution, and did not change significantly over time, nor upon appearance of hypoxia. We found that the rate of oxygen consumption by nitrification could account for up to 85% of the total oxygen demand in the water column or the sediments, but generally was about 20% of total oxygen demand. Denitrification activity was present in all long-term water samples examined, while anammox activity was only found in deep water samples from the central basin. The rate of nitrogen production by anammox was much lower than by denitrification. Diagnostic genes for denitrification (nosZ) and anammox (16S rRNA) were
amplified from all samples and their diversity was assessed by PCR-based clone library construction and sequencing. Our results indicate that anammox activity exists in LE but is less important than denitrification in N-removal from the ecosystem. Over the past decade we and others have observed a change in phytoplankton nutrient limitation from P-limitation to N-and-P co-limitation in the summer. We hypothesize: nitrification contributes to formation of large zones of hypoxia, which in turn leads to increased removal of available N, altering the nutrient status of phytoplankton.

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THE ENDURING PRIMACY OF TOP-DOWN EFFECTS IN SHALLOW BENTHYIC ECOSYSTEMS

Nutrient enrichment is widely believed to be among the most detrimental human activities in coastal ecosystems, and vast sums have been expended to study the negative consequences of nutrient pollution. Most studies of the effects of nutrient enrichment, however, were conducted long after the number and diversity of larger marine consumers had been dramatically reduced by centuries of intense harvesting. It is now understood that these once abundant predators played pivotal roles in regulating ecosystem structure and function, and that the overharvesting of large consumers frequently triggers indirect effects that alter species composition in ways similar to those thought to result from nutrient enrichment. Recent experimental assessments and meta-analyses of the relative impacts of nutrient supply and consumer abundance on algal biomass in seagrass meadows, coral reefs and rocky shores show that while nutrient effects can be significant, consumer effects remain the primary drivers of coastal benthic ecosystem structure and function. And this is true in both tropical and temperate latitudes, and for high and low diversity ecosystems. One important implication of this conclusion is that restoring the species composition and function of coastal ecosystems will be most successful when both nutrients and food web structure are co-managed.

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THE EFFECTS OF FRESHWATER FLOW AND SALINITY ON SHRUB AND GROUNDCOVER COMMUNITIES OF THE LOXAHATCHEE RIVER FLOODPLAIN, FLORIDA

Shrub-layer and groundcover communities have long been used as short term indicators of health in plant communities. While shrub-layer plants show a more intermediate response (yearly) between the tree canopy and groundcover, groundcover communities are subject to quick seasonal changes in their status. Shrub and groundcover communities of the Loxahatche River floodplain were examined on 10 vegetation belt transects in 1993, 2007 and 2010 along with river stage, flow, and surface and groundwater salinity. LiDAR data were used to examine floodplain inundation at various flows. Freshwater flow appears to be the dominant factor controlling salinity in the upper portion of the river, while tidal influence is stronger in the downstream portion. Flow and salinity relationships indicated that a flow of 35 cfs would keep the salinity at River Mile 9 below 2ppt, an important threshold level for freshwater species such as bald cypress, Taxodium distichum. Hurricanes of 2004 and 2005, decreased canopy cover resulting in increased plant diversity in both the shrub and groundcover. The 2007 and 2010 survey data showed that species diversity of both shrub and groundcover communities was during the drought of 2007. Salinities above the targeted 2ppt encroached into soils and surface waters of the floodplain at RM 9.1 for a period of approximately four months in 2007. During the dry season of 2010 higher than average rainfall produced a rebound in freshwater species. Freshwater groundcover species such as bald cypress, pond apple, red maple and water hickory showed significant increases in stem densities to heavily impact seagrass beds, our results suggest that the loss of top predators (e.g. sharks) that also have undergone dramatic declines in many regions. The potential for large predators to modify the spatiotemporal pattern and intensity of herbivory is further complicated by their broad diets and the possibility that they might indirectly influence seagrass communities through multiple pathways that could serve to amplify or attenuate the strength of top-down effects. We used the related pristine seagrass ecosystem of Shark Bay, Western Australia as a model system for investigating top-down effects of grazers and top predators in the absence of major anthropogenic impacts. Using a combination of nested enclosures and seagrass transplant experiments, as well as surveys of habitat use and abundance of tiger sharks (top predators), megagrazers (turtles, sea cows), piscivores, and megagrazers (elephants) we investigated potential shark-induced trophic cascades through multiple pathways. Both pathways appear to have the potential to mediate indirect effects of tiger sharks on seagrasses and likely work in concert to amplify top-down impacts. Combined with other studies showing the potential of grazers at high population densities to heavily impact seagrass beds, our results suggest that the loss of top predators could have important consequences for the structure and stability of seagrass ecosystems.

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DO TIGER SHARKS INFLUENCE SEAGRASS ECOSYSTEMS THROUGH MULTIPLE INDIRECT PATHWAYS?

The importance of large-bodied herbivores in structuring seagrass ecosystems in undisturbed seagrass communities has begun to receive considerable attention. Less appreciated is the possibility that the structuring role of these herbivores was driven by top-down impacts of large predators (e.g. sharks) that also have undergone dramatic declines in many regions. The potential for large predators to modify the spatiotemporal pattern and intensity of herbivory is further complicated by their broad diets and the possibility that they might indirectly influence seagrass communities through multiple pathways that could serve to amplify or attenuate the strength of top-down effects. We used the relatively pristine seagrass ecosystem of Shark Bay, Western Australia as a model system for investigating top-down effects of grazers and top predators in the absence of major anthropogenic impacts. Using a combination of nested enclosures and seagrass transplant experiments, as well as surveys of habitat use and abundance of tiger sharks (top predators), megagrazers (turtles, sea cows), piscivores, and megagrazers (elephants) we investigated potential shark-induced trophic cascades through multiple pathways. Both pathways appear to have the potential to mediate indirect effects of tiger sharks on seagrasses and likely work in concert to amplify top-down impacts. Combined with other studies showing the potential of grazers at high population densities to heavily impact seagrass beds, our results suggest that the loss of top predators could have important consequences for the structure and stability of seagrass ecosystems.
The St. Johns is a sub-tropical Atlantic Coastal Plain river estuary undergoing cultural eutrophication caused by nutrient enrichment. The broad, shallow, elongated freshwater reach of this river estuary exhibits regular spring and summer cyanobacteria blooms, with chlorophyll-a at times surpassing 300 mg m⁻³. Major cyanobacteria genera represented include Anabaena, Cylindrospermopsis, Oscillatoria, Microcystis, and Aphanizomenon. The ultimate dominant among these has significant bearing on the nature of adverse water quality arising from the bloom. Here we present analysis relating the major chemical, meteorological, morphologic and hydrodynamic drivers to species dominance in a particular bloom, based on a 15-year record of chemical and phytoplankton identification and enumeration data. Hydrodynamics, in particular, discharge, is the primary factor in determining bloom composition and intensity. Low flow years shorten the freshwater reach length and producing extremely high dense blooms that expand and crash in place. These low-flow blooms exhibit a stage dominated by nitrogen-fixing cyanobacteria, such as Anabaena and/or Cylindrospermopsis spp., which contribute to nitrogen input to the system. In high flow years, blooms expand longitudinally over time, and often culminate in dominance by the toxic cyanobacterium Microcystis aeruginosa at the seaward end of the freshwater reach. Discharge also determines the extent of the freshwater reach, the timing of bloom peak, the prevailing N:P ratio, the downstream delivery of autochthonous N load, and the photic zone mixing depth ratio at the seaward end of the freshwater reach, additional factors that may contribute to species composition and abundance. A general model is proposed to predict bloom-related water quality effects based on the prevailing discharge and meteorological conditions of a given year.

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**SUBTIDAL VARIABILITY IN THE WATER LEVELS IN THE ST. JOHNS RIVER**

The effects of atmospheric forcing on subtidal water level variations may provide valuable insight to the problem of salt intrusion in the St. Johns River, which is increasingly being used as a drinking water source. Hourly water level data at two St Johns River stations, approximately 60 km apart, and hourly meteorological data from the station nearest the estuary’s mouth were compiled for the summer of 2006. Meteorological data included hourly averages of wind speed, wind direction, and atmospheric pressure. All data were low-pass filtered with a half-period of 25 hours. The wind-induced surface stress was compared to the water level slope between the two stations to explore their dynamic relationship. The St. Johns River does not exhibit a classical wind-driven water surface slope. Instead, a set-up near the estuary’s mouth propagates upstream as a damped wave. Ninety-one percent of the variability in the upstream water levels can be predicted using a damped wave solution, using the water level variations at the estuary’s mouth as the forcing wave. It took approximately 14 hours for the set-up to travel 60 km upstream, i.e., the damped wave propagated at average speeds of 4.3 km/hr or 1.2 m/s. In turn, the variability of the subtidal water level variations at the estuary’s mouth was predicted with a multiple regression model that considered both wind stress components and atmospheric pressure. Eighty percent of the subtidal water level variations at the mouth could be explained by atmospheric forcing. The rest of the variability may be attributed to remote effects.

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**APPLICATION OF WALKER AND SYERS’ BIOGEOCHEMICAL THEORY OF SOIL DEVELOPMENT IN THE ANTHROPOCENE**

In the mid 1970s, Walker and Syers proposed a model describing patterns of soil nitrogen (N) and phosphorus (P) availability during ecosystem development. Briefly, new sediments, composed largely of rock-derived nutrients, are high in P and low in carbon (C) and N. In time, N fixation and atmospheric deposition increase N content towards a theoretical equilibrium N/P ratio, while P enters a biologically unavailable state. Walker and Syers’ model has been extensively applied to describe plant succession, but never to the evolution of biogeochemical processes. For the first time, we apply Walker and Syers’ theory to the evolution of sediment biogeochemistry during the development of a river-dominated deltaic coast in southern Louisiana. The Wax Lake Delta (WLD) first emerged above mean water in 1956, and has evolved through the development of a river dominated deltaic plain estuary. To further test the validity of using the Walker and Syers model for biogeochemical processes, we measured dissolved inorganic nutrient and dinitrogen variability over the same gradient. To further test the validity of using the Walker and Syers model for biogeochemical processes, we measured dissolved inorganic nutrient and dinitrogen variability over the same gradient. To further test the validity of using the Walker and Syers model for biogeochemical processes, we measured dissolved inorganic nutrient and dinitrogen variability over the same gradient.
Hershner, C.

sediment compartments, the role of mangroves and seagrasses as storage/transforms of coupling multiple spatial and temporal scales analyses of nutrient dynamics in the water-functional components. Among the challenges in the research of these ecosystems are to this review indicate that these studies are main focused on descriptive analysis rather than Sea, highlights the lack of the ecosystem approach in most of these studies. Findings from eutrophication. A non-exhaustive analysis of the literature on the nutrient sources (C, N, P, main symptoms are habitat loss (mangroves, seagrasses), harmful algal blooms and 2,430,000 km3. In the Mexican side drains 62% of the country's fresh water, has a coastline AND CARIBBEAN SEA: WHAT WE KNOW AND WHAT WE NEED TO KNOW MEXICAN COASTAL LAGOONS AND ESTUARIES FROM GULF OF MEXICO Morales-Ojeda, S. M., CINVESTA V-IPN, U.Merida, Merida, Mexico, moojsa@gmail.com; Herrera-Silveira, J. A. supply of new N and Si from the ocean. reflects a combination of the dissolution of biogenic opal (accumulated during previous tidal amplitude. During this period non-conservative DSi fluxes were positive and the whole bay became a net source of this element. The net release of DSi from sediments probably source during upwelling relaxation. The biogenic opal that is intensely dissolved near the mouth during relaxation events is most likely supplied by the ocean from diatom blooms. During late summer upwelling was absent and DSi distributions showed a strong control by tidal amplitude. During this period non-conservative DSi fluxes were positive and the whole bay became a net source of this element. The net release of DSi from sediments probably concentrations as storage/transforms of natural and human elements of the system, something that is often easier said than done. The National Estuary Programs are, by design, intended to address entire coastal systems at a variety of scales. They are also specifically focused on engagement of stakeholders and the impacts of human use of natural systems. As such they are ideal test beds for implementation of EBM. The particular opportunities and challenges that confront NEPs in efforts to incorporate EBM principles into their planning and operations will be reviewed in this presentation. While the notion of NEP goals seems perfectly suited for application of EBM principles, the realities of program management frequently confound those aspirations. Organizational structure, geographic scale of programs, federal program interests, and the mix of engaged stakeholders can all have both positive and negative impacts on EBM efficacy. The challenges of developing and using a holistic vision of the managed system will be specifically considered, and options for lessening the impediments to successful EBM implementation will be developed.

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PHYSICAL AND BIOLOGICAL CONTROLS ON DISSOLVED SILICA DISTRIBUTIONS ALONG A LOW-INFLOW, UPWELLING INFLUENCED COASTAL LAGOON Dissolved silica (DSi) distributions along San Quintin Bay (SQB), a low-inflow coastal lagoon in NW Mexico influenced by upwelling events in the adjacent California Current System, were studied under upwelling and non-upwelling conditions. Non-conservative DSi fluxes were quantified by means of a 4-box model (the LOICZ model), to evaluate the role of different sections of the lagoon as sinks or sources of DSi. During the upwelling season, short-term (few-day scale) variability in DSi distributions was determined by the combination of upwelling intensity, tidal amplitude, and the balance between Si uptake and biogenic opal dissolution within the lagoon. During this season, while the inner arms were net sinks of DSi most of the time, reflecting a dominance of Si uptake by benthic diatoms, the region near the mouth switched from net sink during upwelling intensification to net source during upwelling relaxation. The biogenic opal that is intensely dissolved near the mouth during relaxation events is most likely supplied by the ocean from diatom blooms. During late summer upwelling was absent and DSi distributions showed a strong control by tidal amplitude. During this period non-conservative DSi fluxes were positive and the whole bay became a net source of this element. The net release of DSi from sediments probably reflects a combination of the dissolution of biogenic opal (accumulated during previous months as microphytobenthos), which was favored by an increase in temperature, and a decrease in the uptake of DSi from the water column as the lack of upwelling limits the supply of new N and Si from the ocean.

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MEXICAN COASTAL LAGOONS AND ESTUARIES FROM GULF OF MEXICO AND CARIBBEAN SEA: WHAT WE KNOW AND WHAT WE NEED TO KNOW ABOUT NUTRIENT DYNAMICS AND EUROTYPIC SYMPTOMS The Gulf of Mexico is a semi-enclosed basin of 1,942,500 km2 with a water volume of 2,430,000 km3. In the Mexican side drains 62% of the country’s fresh water, has a coastline of 3,200 km with more than 50 coastal ecosystems where they live 15 million people, and, whereas 45% of shrimp, 90% of oysters and 50% of fishes of the country is harvested. The Gulf of Mexico inland activities have caused serious impacts on coastal ecosystems; the main symptoms are habitat loss (mangroves, seagrasses), harmful algal blooms and eutrophication. A non-exhaustive analysis of the literature on the nutrient sources (C, N, P, Si) and trophic status of coastal lagoons and estuaries of the Gulf of Mexico and Caribbean Sea, highlights the lack of the ecosystem approach in most of these studies. Findings from this review indicate that these studies are mainly focused on descriptive analysis rather than functional components. Among the challenges in the research of these ecosystems are to couple multiple spatial and temporal scales analyses of nutrient dynamics in the water-sediment compartments, the role of mangroves and seagrasses as storage/transforms of nutrients among others. The conceptual framework could be associated with connectivity, ecosystem health, resilience and sensitivity/vulnerability to the global change effects.

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OCCUPATION AND CHALLENGES FOR APPLYING ECO SYSTEM BASED MANAGEMENT TO NATIONAL ESTUARY PROGRAMS Ecosystem Based Management (EBM) has evolved to be a relatively plastic term that has been used to characterize a diversity of environmental management efforts. Despite its diverse usage, the concept retains a number of central characteristics which include being place-based and involving system-level consideration of management actions. The system-level thinking is supposed to explicitly include consideration of natural and human elements of the system shares the same experience of being a good example of the synergetic thinking of management into one single program, the National Estuary Program.

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AN ASSESSMENT OF CONNECTIVITY IN ESTUARINE AND COASTAL POPULATIONS IN THE PACIFIC OFF BAJA CALIFORNIA: WHAT DO WE KNOW? Population connectivity refers to the level of exchange of individuals among spatially separate populations that is determined by passive (e.g. dispersal) and active (e.g., migration) processes. Through their connectivity, spatially separate populations have the potential to exchange genetic information and energy, which contribute to their resiliency. Populations with sedentary life history strategies or that are limited in their dispersal capabilities may be vulnerable to exploitation, habitat degradation and climatic and oceanographic variations. The California Current System (CCS) extends along the Pacific coast of North America and spans Canada, the United States and Mexico. Populations of fishes and invertebrates that inhabit this coastline occupy several biogeographical provinces linked by oceanographic processes. There are few studies assessing the level of connectivity among populations along the Pacific coast of the Baja California Peninsula. Even fewer have tried to assess connectivity among populations whose geographical range encompasses more than one country and which are subjected to commercial or recreational exploitation. Phylogeographic studies in the CCS have revealed distributional breaks in the genetic makeup of populations that may be due to biogeographical limits or barriers to gene flow. There are fewer major estuarine systems off Baja California than in the southwestern coast of the US, and these are separated by hundreds of kilometers. We will review the state of knowledge regarding population connectivity of off Baja California in an attempt to identify the life history characteristics, oceanographic processes, and disturbances (natural or anthropogenic) that are most relevant to establishing, maintaining or creating barriers to connectivity. We will identify future research questions relevant to understanding the population structure of coastal populations off Baja California.

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POTENTIAL FOR HUMIC ACID AMENDMENT IN FACILITATING PLANT ESTABLISHMENT IN COASTAL DUNE AND SAWYEE ENVIRONMENTS Restoration success of barrier islands and other sandy coastal habitats requires the establishment of viable and sustainable plant communities. The rapid establishment and expansion of vegetative cover is crucial in trapping and binding sand, thereby increasing resistance to storm and overwash events. Humic acid has been reported to reduce the impacts of environmental stressors associated with growing crops in marginal soils; however, literature on the potential benefits of humic acid in coastal restoration is extremely limited. We conducted a series of greenhouse experiments and a large-scale field experiment on the potential benefits of humic acid amendment and its interaction with nutrient additions on a array of coastal plant species. Greenhouse and field experiments on a subset of these species, sea oats (Uniola paniculata), bitty panicum, (Panicum amarum), and marshhay cordgrass (Spartina patens), revealed differential species responses. Although species displayed positive responses to nutrient addition, the benefit of humic acid amendment in conjunction with nutrient addition was most evident in sea oats and marshhay cordgrass. A currently accepted restoration strategy in Louisiana barrier island restoration projects is broadcast
seeding of coastal Bermuda grass (Cynodon dactylon). This is assumed to rapidly establish an ephemeral, sand-stabilizing species prior to planting the targeted dune and swale species (sea oats, bitter panicum, and marshhay cordgrass). However, results from this study indicate that Bermuda grass may be hindering dune building by restricting aeolian sand transport to the dune zone, which was amplified with nutrient addition since it increased the vigor and persistence of Bermuda grass. Therefore, we recommend that barrier island restoration practices are carefully viewed for compatibility with project goals before Bermuda grass broadcast seeding is implemented as a component of the restoration.

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CATCHING FISHERMEN - ENGAGING COASTAL USERS IN MARINE RENEWABLE ENERGY

“Fishermen in Lincoln County (Oregon) are not standing around with our arms crossed (in regards to wave energy), we are paddling and we are keeping up.” Quoted from fisherman Bob Eder in September of 2008, at the Oregon Wave Energy Trust conference. The demand for alternative energy is here and the ocean is the final frontier, with the promise of offshore wind, current, tidal and wave technologies. In reality, the ocean isn’t the final frontier; it is already highly used, highly valued, and highly demanded. The space desired for wave energy development in Oregon, is some of the most productive crabbings grounds off of the west coast. Coupled with an Oregon directive to create marine reserves, the use for nearshore ocean space is creating an intensely stressed fishing industry and coastal community at large. Involving the coastal community and fishing industry in the decision making process about wave energy development is critical. In Oregon, the fishing industry has relatively little organizational structure, especially for cross-sectored representation, and groups that represent both commercial and recreational fishing were, until recently, non-existent. The successful engagement of these interests involves first building the capacity, giving them to skills to engage, and making sure there is an actual path for their engagement. This presentation describes the challenges and successes of building cross-sectored fishing industry groups and engaging them in the wave energy discussion. Various community based strategies are discussed, as well as examples of how these groups are aiding in the development of wave energy research and development.

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SCIENTIFIC AWARENESS THROUGH THEATER: INSPIRING YOUNG PEOPLE TO VALUE SCIENTIFIC PRACTICE AS WE ADAPT TO CLIMATE CHANGE

We will create two professional quality, 15-minute plays about climate-change research. The first, for grades K-3, is about sea-ice and focuses on a research camp in the Arctic. The main character is a sled dog who explains that scientists study the changing ice to better understand how a warming Arctic will affect the rest of the globe. The second play, targeted to grades 4-6, considers the bacterium Flavilisicus, a “bad bug” in coastal and estuarine waters responsible for 10-20 deaths per year. As the Chesapeake Bay warms, we expect greater incidence of Flavilisicus infections. A resultant promotional video will highlight how scientists, educators, and theater artists work together to communicate climate-change research to young people. We choose to communicate through live theatre because the medium gives us the opportunity to present scientific information in a visually and aurally spectacular manner. The combination of an exciting live event, the opportunity immediately afterward to engage in hands-on activities that replicate scientific practice, plus the on-line presence of instructional games to reinforce concepts serve to engage students on multiple levels. We use live theatre to inspire young people to understand and become engaged in scientific practice.

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EXPLORING THE UTILITY OF THE BROADBAND MULTISPECTRAL SENSOR WORLDVIEW2 FOR INVESTIGATION OF NEARSHORE COASTAL ENVIRONMENTS

The utility of worldview2 (WV2), a commercial sensor, with 50m spatial and 2 meter spectral resolution, was examined for mapping and quantifying submerged aquatic habitats. The big bend and Saint Joseph’s Bay region of Florida with benthic types ranging from bare sand to dense seagrass were used as test areas. Satellite imagery was atmospherically calibrated using co-incident ground based measurements of Rrs. Sand and seagrass were identified based on brightness in the green (510 to 580 nm) band. The bottom reflectance (Rb) of the seagrass canopy was calculated in order to determine seagrass abundance as leaf area index (LAI). We used a simple physics based approach, in which water column optical properties and bathymetry are used to remove the filtering effect of the water column over Rb. Water column optics were measured in situ coincidently with the satellite overpass. Bathymetry was collected using an acoustic survey performed using a combination of a Garmin chartplotter and a Humminbird DGPS. Seagrass abundance was calculated using an empirical relationship between Rb in the green and LAI, growth of the seagrass can be estimated with a series of transfer coefficients from fresh biomass to organic carbon. Using the finer resolution (0.3m) of the panchromatic band, pixels with the geometry of propeller scars (long thin) can be observed. The abundance of prop scarring can be ascertained throughout the image through a combination of brightness and shape analysis. The characteristics of the WV2 sensor dictate that several in situ datasets, mostly importantly water depth and optical properties are known in order to retrieve benthic habitat, however once these properties are known successive images can be processed without the need for further in situ collections.

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MODELING THE EFFECTS OF SEA LEVEL RISE ON ESTUARINE NITROGEN CYCLE: EXAMINING THE FATE AND TRANSPORT OF NITROGEN IN THE CAPE FEAR RIVER ESTUARY, NC, USA

Sea levels are rising as a result of global climate change. Changing salinities in estuarine ecosystems may alter the microbial processes responsible for the biogeochemical cycling of nutrients. The degree to which different storage and processes in the nitrogen cycle will be affected by rising salinity in estuaries is an important concern when considering the effects of global climate change. We developed a mass balance model for the nitrogen budget of an Oregon site (1cm² sections of bottom water and sediment along a salinity gradient in the Cape Fear River Estuary, NC, USA). Two sites, an upstream (oligohaline) site and downstream (euhaline) site, were selected for comparison. Model development placed emphasis on microbial nitrogen storage, export and cycling within the system. The pools of DON, nitrate and ammonium as well as the rates of denitrification and anaerobic ammonium oxidation were measured directly to parameterize the model. PON and the rates of nitrification and dissimilatory nitrate reduction to ammonia were estimated based on published reports. The fate and transport of different nitrogen species traveling through the estuary were characterized by Ecological Network Analysis. Sensitivity analysis was conducted to determine the reliability of the model results and to identify the microbial process most affected by sea level rise. This model may predict responses in the sedimentary N cycle and estuarine N budget as sea level increases.

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CORRECTING LIDAR ERRORS GREATLY IMPROVES DIGITAL ELEVATION MODELS OF SALT MARSHES

Accurate habitat mapping in salt marshes is important for both management and conservation goals. Although many variables affect species patterns in marshes, elevation is one of the most important as it determines the frequency and duration of tidal flooding. Light Detection and Ranging (LIDAR) is effective at measuring surface elevations, however, sensor resolution and instrument errors, coupled with limited laser penetration in dense salt marsh vegetation, mean that uncorrected digital elevation models (DEM) are not generally accurate in marshes. The goal of the current study was to apply species-specific correction factors to a LIDAR-derived DEM obtained for the salt marshes surrounding Sapelo Island, GA using a state-of-the-art Optech Gemini ALTIM LIDAR system. We developed correction factors for ten cover classes using real time kinematic (RTK) GPS in combination with a high accuracy (90%) hyperspectral classification. Mean errors in the uncorrected DEM were largest for tall Spartina alterniflora (0.27 m) and Juncus roemerianus (0.15 m) and smallest for unvegetated salt pans (0.03 m). Application of the derived correction factors greatly improved the accuracy of the LIDAR DEM, reducing the overall mean LIDAR error from 0.10 ± 0.10 (SD) to -0.004 ± 0.09 m (SD), and the Root Mean Square Error from 0.14 m to 0.08 m. In the corrected DEM, the elevations of all vegetation classes were no longer significantly different than the true RTK ground elevations. Our results suggest that these types of corrections can greatly improve the accuracy of DEMs in salt marshes and further emphasizes the importance of accuracy assessments before LIDAR data are used, especially in environments where small differences in elevation can have significant effects on ecosystem processes and plant distributions.

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Our objective was to evaluate the use of the nitrogen stable isotope value ($\delta^{15}$N) of larval fish as an indicator of anthropogenic nitrogen loading to coastal wetlands in the Great Lakes. We sampled oysters (3 densities) at 4 sites across a nutrient gradient in Jamaica Bay, NYC. Oysters were contained in mesh cages and suspended above sand-filled boxes. For 1 year, we measured oyster feeding and excretion rates and water quality monthly, and sediment organic matter, exchangeable ammonium, nitrification, and denitrification bimonthly. Oysters increased sediment organic matter, exchangeable ammonium nitrification, and denitrification at initial stages of the experiment when organic content of sediment was lowest, but had no effect as sediment organic content increased for the remainder of the study. We measured positive correlations between organic matter and exchangeable ammonium, exchangeable ammonium and nitrification, and nitrification and denitrification. However, these positive correlations emerged when comparing data across sites and dates, and not among oyster treatments. Our results suggest oysters influence N cycling when organic content is low. Otherwise, environmental factors which drive high pelagic production, and not the intensity of oysters, control sediment organic matter and N dynamics in this eutrophic embayment.

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CLASH OF THE TITANS: INVESTIGATING GENETIC VARIATION IN THE GLOBAL EXOTIC TITAN ACORN BARNACLE MEGABALANUS COCCOPOMA

The Titan Acorn barnacle, Megabalanus coccopoma, is a recent and potentially detrimental invader to the southeastern United States as well as other locations including Japan, Australia, and South America. To better understand species persistence, we sought to determine whether these exotic populations harbor low levels of genetic diversity (suggesting a population bottleneck) and if invasive populations were comprised of different sets of genetic haplotypes (suggesting independent invasions). To address these hypotheses, we used PCR to amplify 608 base pairs of the mitochondrial cytochrome oxidase I (COI) gene from approximately 25 individuals from 2 native and 10 exotic populations of Titan Acorn barnacles and included publicly available data from 2 additional exotic populations. We also sequenced several individuals for the mitochondrial 16S rRNA gene to help differentiate between morphologically similar barnacle species. Using these data, we found that some populations consisted of multiple lineages of putatively different species. However, M. coccopoma was the most common and widespread species. The sequence variation of COI in M. coccopoma samples revealed that levels of diversity between the native and exotic populations were not significantly different. Moreover, genetic analyses revealed that native and non-native populations exhibited high levels of population similarity (Fst=0.015) with common haplotypes shared among all populations indicating high gene flow, even between native populations. These data suggest that multiple cryptic species of barnacles have spread globally, that M. coccopoma is the most widespread species, and that exotic populations are as genetically diverse as native populations. These data help us to better understand invasive population management and containment, with the ultimate goal of the preservation of the natural ecology.

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PATCH SIZE-DEPENDENT COMMUNITY RECOVERY AFTER MASSIVE DISTURBANCE

Massive disturbances are now common in ecosystems worldwide, generating widespread die-off and subsequent community recovery dominated by remnant patch, rather than open gap, dynamics. Whether communities can recover and, if so, which factors mediate recolonization rate and extent remain unresolved. Here we evaluate recolonization dynamics of southern U.S. salt marshes that experienced extensive, drought-induced die-off of the foundation species Spartina alterniflora over the previous decade. Surveys of Georgia marshes showed little seedling recruitment in die-off areas but persistence of Spartina particularly in large, rather than small, remnant patches. Given this natural variation in remnant patch size, we conducted field experiments to test whether key plant-controlling biotic (grazing, plant neighbor presence) and abiotic (water availability) factors differentially impact Spartina recolonization at small and large patch scales. In the small patch (~1m2) experiment, removing grazers and plant neighbors prompted much higher expansion and growth of Spartina relative to controls, while adding freshwater to reduce water limitation had little effect. In contrast, large patch (~20m2) borders advanced significantly over the same time period regardless of grazer or neighbor removal. We continued the large patch experiments over the following year that experienced drought and also added freshwater or salt to borders to modify ambient drought stress: overall, borders advanced less than the previous year but significantly more where neighbors were removed or freshwater added. Thus, water availability appears to mediate Spartina recovery by fueling large patch expansion during wet summers and intensifying interspecific competition during drought. Combined, these findings suggest ecosystems can recover from massive disturbance if remnant foundation species’ patches are large enough to overcome biotic inhibition and successfully expand during periods of relaxed abiotic stress.

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Western Australian seagrasses are world famous for their tremendous areal distribution and high diversity whereas little is known about the sediments they are growing in. The sediments in WA are almost as diverse as the seagrasses extending from carbonate or siliciclastic sediments with low organic contents to silty high organic sediments. In this study we collected 5 different seagrass species (Amphibolis australis, Halophila ovalis, Zostera nigricaulis, Posidonia australis and P. sinuosa) growing in 4 different types of sediments. The sediments are all low in organic matter pools, except for one sheltered site, and sulfate reduction rates are low compared to seagrass sediments elsewhere, probably controlled by low burial of organic matter and oxidation of the sediments in the high energy environment. Despite this fact, high sulfide intrusion was found in the below-ground parts, similar to observations from elsewhere, and very low iron pools in the sediments may contribute to the high sulfide intrusion. The sulfide intrusion into the leaves varied between species, most likely determined by the differentiation of the shoots, where seagrasses with long stems (A. amphibolis) and large vertical and horizontal rhizomes (P. sinuosa and P. australis) show less sulfide intrusion compared to smaller species (H. ovalis and Z. nigricaulis), where the intrusion in the leaves was directly coupled to the intrusion in rhizomes and roots. The high intrusion of sulfides observed at several of the study sites may be an early warning indicator of environmental stress, and we recommend long-term monitoring of the seagrass population dynamics at these sites.

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GENETIC DIVERSITY OF HIGH-LATITUDE THALASSIA TESTUDINUM COMMUNITIES IN BERMUDA

The central–marginal and abundant center models predict declines in genetic diversity nearing the geographic edge of a species’ distribution range. As such, Bermuda seagrass populations would be expected to have low genetic diversity. Additionally, Bermuda’s geographic isolation may impede gene flow, even for species with long-distance dispersal capability like turtlegrass (Thalassia testudinum). We used eight codominant microsatellite markers to evaluate the genetic diversity of triplicate inshore and offshore T. testudinum meadows in Bermuda, which is the northern limit of the species in the Atlantic Ocean. Results reveal patchy genetic structures in space and higher clonal richness than expected from both classical population genetics theory and molecular data on T. testudinum populations at the species’ margin in Florida waters. The variable genetic structures we observed may be attributed to habitat fragmentation and local disturbance regimes. Our findings offer important insight into the adaptive potential of high-latitude seagrass communities to environmental change as well as guidance for T. testudinum transplant-driven restoration currently underway in Bermuda.

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IMPROVED TOOLS FOR CALCULATING NANI (NET ANTHROPOGENIC NITROGEN INPUT) IN THE WATERSHEDS OF U.S. AND EUROPE

NANI (Net Anthropogenic Nitrogen Input) is calculated as the sum of oxidized N deposition, fertilizer N application, agricultural N fixation, and N in net food and feed imports. It has been calculated in many watersheds of the U.S., Europe, and other parts of the world at various scales to estimate the human-induced nitrogen inputs to the region of interest, and has been shown to have a strong relationship with riverine nitrogen export. Recently, a set of tools referred to as NANI Calculator Toolbox has been developed, which allows the user to calculate NANI and its components anywhere in the US from a map of watersheds as input. Here we describe new functionalities being added to the toolbox to enhance its applicability to regions outside the U.S. and to generally improve its flexibility. Three examples of such additions are discussed: (1) allowing spatial variation in NANI parameters, which is particularly useful where the coastal watersheds from several countries draining to international waters are subject to varying agronomic practices and dietary preferences, (2) making calculations of fluxes of other elements, such as P for NAPI (Net Anthropogenic Phosphorus Input) calculation, and (3) developing a version of the toolbox that can be called as a function which returns appropriate values in response to varying parameters and variables, useful for various analyses such as Monte Carlo-based uncertainty estimation. Specific illustrations of their applications to the U.S. NOAA’s CAF (Coastal Assessment Framework) drainage areas and the Baltic Sea catchments in Europe are presented.

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APPLICATION OF ARTIFICIAL INTELLIGENCE FOR ECOSYSTEM SERVICES (ARIES) FOR ASSESSING FLOWS OF Ecosystem services RELATED TO SUSTAINABILITY FISHERIES AND COASTAL PROTECTION IN MADAGASCAR

We will demonstrate the application of Artificial Intelligence for Ecosystem Services (ARIES) to the context of modeling the flows of ecosystem services related to subsistence fisheries and coastal storm protection in Madagascar. This approach allows for the explicit linkage between ecosystem service source areas and users deriving benefits along Madagascar’s coastal fringe. The ARIES fisheries model focuses on the subsistence use of fisheries as the only class of beneficiaries, currently excluding both recreational and commercial fisheries. The model relies on global spatial data sets for fisheries, population density and poverty, combined with non-spatial data on national fisheries use from publicly available data sources. The coastal storm protection model is a proof-of-concept framework to spatially link: 1) storm wave source locations; 2) ecosystem “sinks” that mitigate wave damage; and 3) social groups and built capital that are susceptible to harm by coastal flooding. We use historic storm track, wind speed, and atmospheric pressure data from several well documented storms in the region to calibrate the model. Currently the coastal protection model does not incorporate external process models to quantify, e.g., storm surge, wave mitigation, or wave run-up, however, the flexible architecture of the ARIES modeling platform allows for the inclusion of existing process models. While we do not directly use external models, the Bayesian models do incorporate important elements of coastal process models to inform their structure. In both instances, the conceptual models for fisheries and coastal storm protection can be generalized to other coastal locations, as they rely primarily on freely available data sets that span the entire globe. Finally, we will demonstrate ARIES’ web-based application which has been developed to support local decision-making related to subsistence fisheries and coastal protection in Madagascar.

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GULF OF MEXICO OIL SPILLS: IS FLORIDA’S EAST COAST VULNERABLE?

U.S. consumers and businesses get nearly half their oil from domestic production, most of it from the gulf region. We are increasingly dependent on ultra-deepwater sources as conventional U.S. oil production has been in decline since the 1970s, and near-shore production along the Gulf Coast peaked in 1997. Most oil analysts expect ultra-deepwater production to continue to increase, in the Gulf and worldwide. Because of increased risk associated with ever deeper drilling, the chances for major oil spills, like the DWH spill, increases as well. To understand the vulnerability of waters and coasts outside the Gulf of Mexico to Gulf spills, requires an understanding of the fate of oil originating from ultra deep waters: as influenced by physico-chemical processes in the water column and transport in ocean currents. Key physico-chemical processes include buoyancy, stratification, dissolution, emulsification, sedimentation and biodegradation. Advection of oil within and outside the Gulf is driven by ocean currents and wind, primarily the Loop Current and the Gulf Stream. The East Coast of the U.S. was largely spared oiling from the DWH spill because of a spin-off eddy that broke off from the Loop Current, thereby blocking penetration of the Loop Current to the DWH locale. Eddy Franklin persisted for almost the duration of the uncontrolled DWH flow. If oil had entered the Loop Current, oil would have traveled a 1000 miles and have reached the east coast of FL in only days. Winds and upwelling could then have transported oil onto beaches.

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CLIMATE RELATED SEA-LEVEL VARIATIONS OVER THE PAST TWO MILLENNIA

We present new sea-level reconstructions for the past 2100 years based on salt-marsh sedimentary sequences from the U.S. Atlantic coast. The data from North Carolina reveal four phases of persistent sea level change after correction for glacial isostatic adjustment. Sea level was stable from at least BC 100 until AD 950. It then increased for 400 years at a rate of 0.6 mm/yr, followed by a further period of stable, or slightly falling, sea level that
perished until the late 19th century. Since then, sea level has risen at an average rate of 2.1
mm/yr, representing the steepest, century-scale increase of the past two millennia. Using an
extended semi empirical modeling approach, we show that these sea-level changes are
consistent with global temperature for at least the past millennium.

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BALANCING THE NEEDS OF BOATERS AND SEAGRASS ECOSYSTEMS IN SOUTHWEST FLORIDA

As Florida’s population grows, so does the number, size, and power of boats used on the
state’s coastal waterways. The growth in boating has put intense pressure on ecologically
important nearshore environments like seagrass beds. Two of the main impacts on seagrass
beds are an increase in the incidence of prop scars and greater pressure for maintenance
dredging of navigation channels. These activities damage seagrass beds, thereby
compromising the numerous ecosystem services that they provide to coastal communities.

Current policy is focused on decreasing the occurrence of these disturbances and mitigating
for any destruction that does occur. However, the policies governing seagrass protection and
mitigation can be so cumbersome that they prevent dredging that is needed by local boating
communities. A typical component of mitigation is restoration and, in Florida, the amount of
restoration needed is determined by the Unified Mitigation Assessment Method (UMAM).
However, UMAM was developed for wetland mitigation and its application to seagrass is
problematic, given the ecological differences between seagrass and wetlands. The Unified
Mitigation Assessment Method also relies heavily on the use of mitigation banks, which
typically are privately owned commercial ventures. In Florida, most seagrass is found on
sovereign submerged lands held in trust by the state (public land), making mitigation banks
difficult to establish. Since continued anthropogenic impacts to seagrass are unavoidable, it
is critical that more effective restoration policies be implemented. We suggest that there
should be a regional plan that identifies areas in need of restoration and a mitigation banking
approach be considered as a means to further seagrass restoration. A summary of the policy
regulating seagrass protection and restoration that led us to this conclusion will be covered in
this presentation.

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OCURRENCE OF ANAMMox IN INTERTIDAL MARSHES OF THE YANGTZE ESTUARY

Over the past several decades, concentration of nitrate in the Yangtze estuarine and coastal
water has increased by more than tenfold, due to human activities in the Yangtze River
Basin. As a result, the excessive accumulation of nitrate has caused the severe eutrophication
in the estuarine ecosystem. Therefore, it is of significance to trace the fates of nitrate.
Anaerobic ammonium oxidation (anammox) has been reported to play a significant role in
the removal of nitrate in anaerobic aquatic ecosystems. Anaerobic ammonium oxidation in
the intertidal sediments of the Yangtze Estuary was investigated using slurry experiments
combined N-15 isotopic trace technique. In addition, anammox bacteria were determined,
which also confirms existence of the anammox process at the study area. It is shown that the
rates of anammox ranged from 7-154 μmol 29N2 kg-1 d-1. However, higher anammox rates
appeared in summer (25-154 μmol 29N2 kg-1 d-1) and fall (15-153 μmol 29N2 kg-1 d-1),
followed by spring (19-52 μmol 29N2 kg-1 d-1) and winter (7-24 μmol 29N2 kg-1 d-1). Also,
the anammox rates were relatively higher in the fresh-water marshes than in the salt
marshes. It is observed that the spatio-temporal changes of the anammox rates were
significantly affected by sediment characteristics including salinity, sediment temperature
and the contents of sulfide and organic carbon. Compared with the reduction fluxes of
nitrate, the anammox process approximately contributed 5-23% of nitrate removal at the
study area.

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BIOPHYSICAL FEEDBACKS IN BARRIER ISLAND TRANSGRESSION

This paper examines the biophysical feedbacks that control the response to and recovery of a
barrier island to tropical storms and hurricanes, which in turn rate of island transgression with
relative sea level rise. Using Santa Rosa Island in northwest Florida as an example, it is
shown that the response and recovery of the island to extreme storms is geologically
controlled by a transverse ridge and swale bathymetry on the inner-shelf. These ridges are
transgressive features that formed from the seagrass beds, brackish marsh and maritime
forest at the cuspate headlands along the backbarrier shoreline. Emergence of the mud-cored
swales on the Gulf of Mexico shoreface forced an alongshore variation in beach-dune
morphology that controls the aeolian transport potential and sediment supply. Field data
suggest that there is insufficient sediment within the washover corridors for dune recovery
(or post-storm recovery), even if vegetation itself is able to recover. Recovery is promoted at
the cuspate headlands by rapid beachface recovery that provides sufficient sediment for
dune building. From a management aspect, it is argued that the resiliency of the island is not
dependent on natural and managed recovery of the washover and washovers, but is dependent
on the ability of the dunes at the backbarrier cuspat headlands to recover in height and
extent.


INFLUENCE OF SALINITY AND HYDROLOGY ON INTERACTIONS BETWEEN
MANGROVES AND EMERGENT MARSH VEGETATION: A GREENHOUSE
STUDY

The distribution of mangrove forests and emergent marshes in Florida, USA, is influenced
by several factors, including those vulnerable to the effects of climate-induced change.
Expansion of mangroves can be facilitated by accelerated sea-level rise, which can transport
propagules further upslope and also alter salinity and flooding regimes that influence
propagule establishment. We studied the effects of salinity and hydrology on the
establishment and growth of two North American mangrove species. Mesocosms, consisting
of the intact plant community and soil, were collected from a southwest Florida marsh
dominated by the perennial grass Distichlis spicata. The mesocosms were subjected to
treated combinations of salinity (0, 15, 28 psu) and hydrologic condition (continually
flooded, tidal) in a greenhouse setting. Propagules of the mangroves Avicennia germinans
and Laguncularia racemosa were introduced to the mesocosms, and both species were also
placed in pots as monoculture plantings. We monitored propagule establishment and
measured seedling height. There was significantly higher establishment success for
Avicennia germinans in monoculture plantings compared to mesocosms at 12 weeks. There
was no difference, however, in establishment success for Laguncularia racemosa. After
15 months Avicennia germinans height in mesocosm plantings was lower in freshwater than in
saltmarsh treatments regardless of hydrology. Height of this species in monoculture varied
with both salinity and hydrology; it was greatest in tidal compared to flooded treatments and
was greatest under intermediate salinity conditions. Salinity alone affected height in
Laguncularia racemosa, with greatest height occurring at intermediate salinity in both
mesocosms and monocultures. Our results indicated that the presence of marsh vegetation
reduced seedling recruitment for one of the species studied. Salinity, however, had the greatest
influence on both establishment and growth.

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SEAGRASS DIEBACK IN A SHALLOW LAGOON: RESPONSE OF GROSS
PRIMARY PRODUCTION AND NITRATE CONCENTRATIONS

We have tracked the ecological and biogeochemical response of West Falmouth Harbor, a
small lagoon on Cape Cod, to a large increase in nitrogen load since 2005. In the inner part
of the harbor subject to the greatest nitrogen load, summer-time rates of gross primary
production were high from 2005 to 2009. Significant inter-annual variability in rates appears
to be controlled by inter-annual variability in the nitrogen load, which in turn is driven by
climate and groundwater geology. Seagrasses remained in the inner harbor through 2009,
and together with attached epiphytes, were major contributors to gross primary production.
A major dieback of seagrasses occurred in 2010, perhaps triggered by an unusually high
nitrogen load. The loss of seagrasses resulted in much lower rates of gross primary
production, less diel change in oxygen concentrations, and less tendency towards hypoxia
during the night. By these measures, the loss of seagrasses resulted, paradoxically, in what
might be characterized as a less eutrophic and “healthier” ecosystem. On the other hand,
nitrate concentrations which had remained low from 2005 through 2009 increased
dramatically with the loss of the seagrasses in 2010.

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DIFFERENCES IN FOOD WEB CONNECTIVITY ACROSS INTERTIDAL
GRADIENTS IN EMBAYMENT AND FLUVIAL DOMINATED ESTUARIES

Recent studies in estuarine detritus-based food webs have documented strong gradients in
the sources of organic matter assimilated by consumers across diverse landscape scales.
These results challenge prior concepts (i.e., estuarine outwelling paradigm) regarding the
scale of food web connections across estuarine ecotones, as they infer greater
compartamentalization of food webs in relation to landscape segment. However, these recent
studies were conducted in microtidal environments and/or estuaries receiving little riverine
sediments.
input, both of which minimize detrital transport. Given how little attention has been paid to distinguishing the scale of food web connections in relation to landscape setting and river flow regimes, the goal of this project is to quantify the strength, temporal, and spatial scales of food web connectivity among adjacent ecosystems and across different gradients of fluvial forcing. We use multiple stable isotopes in combination with multiple source mixing models to trace primary producer contributions to consumers transplanted to specific locations across estuarine systems, including emergent marsh, mudflat, Japanese eelgrass, and native eelgrass. The study is being conducted in five Pacific Northwest estuaries (Skagit, Stillicumash, Samish, Padilla, Mud Bay) representing a gradient of fluvial forcing. By tracing the lengths and strengths of ecosystem connectivity, it is possible to determine the spatial extent of trophic linkages required to adequately capture functional food web processes. The comparison among estuaries provides insight into the role that river flow plays in connecting the food webs of adjacent ecosystems. Contrary to expectations, emerging data suggest food webs of more strongly fluvial estuaries are more compartmentalized than those of embayment type estuaries.

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EXCHANGE BETWEEN AN ESTUARY AND AN INTERTIDAL MARSH AND SLough

The hydrodynamic characteristics of small, intertidal perimeter habitats make flushing and residence times in these environments difficult to quantify using conventional approaches. For example, the flooding and draining of intertidal shallows surrounding small perimeter sloughs result in large volume changes relative to the total volume of these systems during each tidal cycle. In such environments, an Eulerian framework of flushing and residence time may not be the best approach for quantifying tidal exchange. Large tidal variations in area, volume, and depth and relatively sharp variations in bathymetry which are associated with intertidal perimeter sloughs complicate measurement and analysis of fluxes using classic estuarine techniques. Thus alternative approaches should be considered in analyzing hydrodynamic exchange in small perimeter habitats. The results of such an approach as applied to a small intertidal perimeter slough in South San Francisco Bay are presented. Previous work has shown that hydrodynamic exchange in an estuarine system can be analyzed by making Eulerian measurements of hydrodynamic fluxes and binning them according to salinity and temperature classes, thus providing a quasi-Lagrangian method of analyzing bulk transport and mixing of salinity and temperature. This method of analysis enables an estimate of the volumetric exchange ratios, which represents the fraction of tidal water exchanged within an estuary during a each tidal cycle. Through the results of our study we find that volumetric exchange ratios may be much greater in small perimeter sloughs than in larger estuarine systems, suggesting that such quasi-Lagrangian approaches may be more useful than conventional Eulerian approaches in understanding hydrodynamic exchange in small perimeter habitats.

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TROPHIC TRANSFER OF HEAVY METALS IN FOOD WEB FROM THE PEARL RIVER ESTUARY, SOUTH CHINA

We examined transfer patterns of copper (Cu), lead (Pb), zinc (Zn) and cadmium (Cd) in the food web of the Pearl River Estuary (PRE) in southern China using stable carbon and nitrogen isotopes as indicators of energy sources and trophic level (TL) for aquatic consumers. Linear regression of log-transformed concentration of metals versus TL in the estuarine food web was used to determine a trophic magnification factor (TMF). A TMF of >1 for Cu was found in the mollusc-crab food chain, indicating potential Cu biomagnification in this partial benthic food web; whereas a TMF of <1 was found for Cd in the mollusc-crab chain and for Zn and Cd in the whole food web, and a significant negative correlation between the log[Cd] and TL in the benthic food web suggested probable biodilution of these metals. The TMF varied between a food web and its specific food chain, indicating that metal transfer within a food web may possibly hide transfer patterns of metals in specific food chains in the PRE. Thus, the transfer of metals along a food chain from the PRE or a similar estuarine and costal system should be closely examined in future studies.

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DEEPWATER HORIZON OIL IN FLORIDA SANDY BEACHES

We present results on our study investigating the fate of Deepwater Horizon crude oil that was washed onto Florida beaches and its impact on microbial communities in these sands. Thick layers of crude oil were deposited and subsequently embedded in Pensacola beach sands. Dispersed and fine-particulate oil fractions stained thick layers of the beach changing cohesiveness of the sand, its wettabillity and permeability. Oiled sand layers show elevated rates of respiration, indicating biological decomposition activities associated with the hydrocarbons. Bacterial strains isolated from oiled beach sands confirmed that oil-degrading microorganisms were associated with the oil layers at increased abundances. The deep cleaning procedures conducted by BP removed most of the deep concentrated oil layers in the public beaches but the sifting of the contaminated sand dispersed tar balls into very small particles that now are mixed in the surface layers of the beach sediment.

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HYDROLOGIC VARIABILITY IN A SALT MARSH: ASSESSING THE LINKS BETWEEN DROUGHT AND ACUTE MARSH DIEBACK

Acute marsh dieback (AMD) observed along the Gulf Coast and South Atlantic Bight in the early 2000s coincided with significant drought. Drought could trigger dieback by increasing the salinity of porewater or by drying and oxidation of marsh soils, but the impact of hydrologic variability on porewater conditions in salt marshes is poorly known. To assess these links, we installed piezometers and passive diffusion samplers in a salt marsh island at North Inlet, South Carolina, where AMD occurred in Fall 2001. The island was typically inundated twice a day, but we observed one three-day period (March 2008) during which the marsh was not inundated. Despite significant drainage from marsh sediments during this period, no redox changes were observed, and tidal records indicate no similar period of exposure during the 2001 drought. Thus drying is unlikely to have triggered dieback at this site. Porewater salinity during the study ranged from 14 to 41 ppt, reflecting interactions between precipitation, ET, surface water salinity, and tides. Salinity was most variable near the surface and increased with depth, reflecting the effects of root zone evapotranspiration. Field observations, supported by general linear model analyses, indicated salinity extremes were more likely to occur during periods with greater numbers of non-inundating high tides. Regression models suggest that porewater salinity was high for several weeks in the fall of 2001 when dieback occurred. Tidal and drought records for Louisiana and Georgia indicate that conditions were favorable for the formation of hypersaline porewater coincident with AMD formation in these states as well. Drought frequency is likely to increase over the next century; damage caused by potential increases in the frequency of drought-related AMD may restrict the ability of intertidal salt marshes to accommodate sea level rise.

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IDENTIFYING FACTORS THAT INFLUENCE EXPRESSION OF EUROTYPHICATION IN A CENTRAL CALIFORNIA ESTUARY

Coastal eutrophication models have proposed that various environmental conditions can serve as filters, mediating the effects of nutrient loading on coastal ecosystems. Variation in such filters due to natural or anthropogenic causes can potentially lead to varied responses in overall eutrophication expression as well as individual eutrophication indicators. In this study we sought to identify factors that affect eutrophic expression at contrasting sites within one nutrient loaded estuary in central California. We developed and applied an eutrophication expression index to 18 sites in the Elkhorn Slough estuary and then used Principal Component Analysis of environmental drivers (nutrients) and filters to determine how they relate to overall eutrophication expression as well as individual eutrophication indicators. We also examined the relationship between one key filter, tidal range, and eutrophication indicators. Elkhorn Slough was determined to be a moderately eutrophic estuary, with individual sites varying from low to hyper-eutrophic expression. Eutrophic expression was explained mostly by tidal range, depth, temperature, salinity, and turbidity, but not by nutrient concentrations. Tidal range in particular correlated strongly with most eutrophication indicators. Sites with artificially dampened tidal range through water control structures were more eutrophic than those with full tidal exchange. Results from this study emphasize the importance of filters in mediating the negative ecological effects of eutrophication. Coastal managers can decrease eutrophication expression at a local scale by managing for filters (e.g. increasing tidal exchange to managed wetlands), complementing efforts at a regional scale to reduce eutrophication by decreasing nutrient loading.

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PLANNING FOR CLIMATE CHANGE ADAPTATION

Adapting to changes imparted to natural and built environments by climate change requires proactive planning and a clear set of short, intermediate and long-term goals and actions. The intertwining of the natural and built systems, especially coastal systems, amplifies the need for cost effective solutions and integrated planning to ensure long-term sustainability. Moreover, successful adaptation will help maintain or restore the health of coastal ecosystems (e.g., barrier beaches, wetlands, and coral reefs for flood protection) necessary
for sustainability and the maintenance of ecosystem services that help to protect the built environment. This paper introduces a scenario based approach for proactive adaptation planning that incorporates consideration of both the natural and built environments to set the stage for a series of papers that consider ways of adapting natural systems to support long-term coastal adaptive planning.

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**CHARACTERIZATION OF PHYTOPLANKTON COMMUNITIES USING A NOVEL SUBMERSIBLE IMAGINE FLOW CYTOMETER - FLOWCAM®**

The study of plankton dynamics and particularly harmful algae is limited by a lack of data at the appropriate temporal and spatial scales. This is in part due to the lack of in situ tools that can sample continuously, forcing researchers to depend on limited data measured by labor intensive laboratory methods or reliance on surrogate parameters. Research and monitoring in ocean and coastal regions would also benefit from an ability to quantify and characterize plankton on a continuous, real-time basis, and at higher spatial resolution. To address these measurement needs, we have adapted a well established digital imaging flow cytometer, Fluid Imaging Technologies’ FlowCAM®, for in situ deployment. The new Submersible FlowCAM model retains the capabilities of the popular FlowCAM® instrument and can operate autonomously at depths to 200 meters under user controlled operations. The unit captures an image of particles for further analysis and cell identification by the user using image recognition algorithms. While the submersible FlowCAM® is primarily designed for deployment on moorings/buoys, its design is consistent with deployment from ships, AUVs, ROVs, buoys, and manned submersibles. This presentation describes this new instrument, including a new and novel anti-biofouling technology. Data will be presented from profiling and time-series deployments.

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**COUPLING LOW SALINITY ZONE HABITAT WITH PULSED ISOHALINE POSITIONING TO QUANTIFY RESOURCE-BASED FRESHWATER INFLOW**

A resource-based approach was applied to establish targets and quantify freshwater inflow requirements to support a water reservation for the estuarine portion of the St. Lucie River, FL. The low salinity zone, defined in this application as the dynamic area encompassing 0 to 10 psu, was identified as critical nursery habitat for larval and juvenile fishes. Freshwater inflows produce a temporal and spatial overlap between the low salinity zone and the nursery area. Within this zone, the ecologically beneficial turbidity maximum and chlorophyll a are contained. Available empirical data indicated that the 1 psu isohaline corresponds to the location of the turbidity maximum. An important consideration in the application of this approach is to maintain the dynamic nature of the isohaline location via pulsed inflows. In contrast to constant inflows, pulsed inflows shift the freshwater/saltwater interface to different locations and generate interaction between inflow and the daily tidal cycle. Pulsed flows may also increase mixing and reduce salinity stratification and are consistent with the “natural flow paradigm” – a recognition that rainfall based ecosystems have evolved with, and depend upon naturally variable flows of freshwater. Using a combination of modeling tools, different pulsed-based flow scenarios were developed and evaluated. The slow retreat of the isohaline created by pulsed flows supports maximum re-suspension and trapping of bottom sediments and benthic organisms within a defined area allowing for favorable feeding conditions for fish larvae utilizing this productive, dynamic habitat.

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**STAKEHOLDER PERCEPTIONS OF ECOSYSTEM SERVICES OF COASTAL HABITATS**

Ecosystem services (ES) of coastal habitats are disproportionately greater than those provided by most other natural systems. In order to identify ES provided by coastal habitats within the Nueces/Corpus Christi Bay area in Texas, a workshop was conducted at which stakeholders were asked to complete surveys. Stakeholders at the workshop represented agencies from three main levels of government and private and public affiliations. Habitats assessed were: seagrass bed, salt marsh wetland, (intertidal) flat, beach, marine/open water, oyster reef, scrub-shrub wetland, freshwater wetland, tree canopy/live oak moke, dune, and rookery island. A spatial representation of the number of ES provided by habitats was created in the form of a “heatmap.” Results of the study and the heatmap were incorporated into an ecosystem-based management plan in an attempt to ensure future economic development strategies are consistent with maintaining ES. In addition to potentially guiding management decisions, the present study documents ES provided to local stakeholders and identifies education and research needs related to ES and coastal habitats.

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**NUTRIENT SOURCES SUPPORTING CHRONIC ALGAL BLOOMS IN THE TIDAL FRESHWATER JAMES RIVER ESTUARY**

Tidal freshwater reaches of estuaries may play a particularly important role in mitigating nutrient fluxes from watersheds to the coastal zone due to their location at the interface between riverine and estuarine systems. The tidal freshwater portion of the James River Estuary experiences chronic algal blooms and is therefore considered impaired due to persistently high chlorophyll-a concentrations. Given local Watershed Implementation Plans associated with the Chesapeake Bay TMDL, knowledge about nutrient sources and retention within tidal freshwater is important to management decisions. We developed annual N and P budgets for 2007-2010 based on riverine inputs at the Fall Line, local points sources, and estimates of tidal flushing losses. Input fluxes indicate that on an annual basis, riverine and point sources contribute equally to TN loads, whereas riverine sources dominate TP loads. During bloom-forming conditions (May-Sep), point sources dominate TN and TP loads, though both TN and TP inputs during high discharge (May 2008-2009 and June 2009) can occasionally exceed point sources. Persistent seaward declines in inorganic nutrient fractions suggest that tidal flushing and biotic uptake are important mechanisms of nutrient transformation in the region of the chlorophyll maximum. Further efforts will partition the relative importance of these mechanisms.

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**ANATOMY OF A PICOPLANKTON BLOOM IN A SUBTROPICAL CENTRAL FLORIDA LAGOON**

Sarasota Bay, FL is a subtropical lagoon surrounded by a heavily populated urban region. The greater bay lacks significant fresh water sources and has low coastal ocean exchange. Salinities can reach near 39 PSU during the dry season. A phytoplankton species composition shift was recorded in Sarasota Bay Florida by the Florida Fish and Wildlife Research Institute’s Harmful Algal Bloom Marine Autonomous Platform (FWRI HAB MAP). The data indicated that, following the bloom, chlorophyll a concentrations would increase. Several days after a peak in chlorophyll a concentration, the
chlorophyll fluorescence peaked in conjunction with phyocyanin fluorescence. Discrete cell counts from a biweekly cruise that coincided with high chlorophyll concentrations, revealed that chlorophyll containing picoeukaryotes were dominant followed by cyanobacteria. Diatoms had been the dominant taxa. During the picoplankton bloom, biogenic silica was at a low point for this site but silicate concentrations were at their highest. Dissolved inorganic nitrogen and phosphate levels were low with N:P ratios near Redfield ratios, but particulate N:P ratios were elevated from near Redfield ratios to 89 during this bloom. The dissolved organic N:P ratio increased from a mean of 47 to 462 during the bloom. A neural network analysis revealed that water temperature, salinity, turbidity, and pH had the highest sensitivities in predicting urea and chlorophyll concentrations (see Millie et al presentation). When the urea data were filtered to include only periods where there was no rain in the previous three days, the urea concentrations above the median value covaried with a SE alongshore wind direction. This picoplankton bloom appears to be the result of high rainfall following a dry period resulting in high dissolved organic nitrogen due to terrigenous runoff. An increase in water temperatures and wind driven circulation were factors in high chlorophyll and urea concentrations.

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MAPPING AND ASSESSING SHORELINE CHANGE ALONG THE GEORGIA COAST: A 2D, 3D, AND 4D PERSPECTIVE

Barrier island and estuarine shorelines along coastal Georgia are diverse in their composition, shapes, and movements. Shorefaces can include low-profile sandy oceanfronts, dense to moderately vegetated dunes and sediment banks, maritime forests, and marsh platforms dissected by laterally migrating tidal streams. Shoreline shapes can range from curvilinear to highly sinuous depending on the processes acting upon the shore. Recently, a coast-wide shoreline GIS was built with historical shorelines from 1855 to present and new analytical tools developed to assess and monitor shoreline change and evolution. Shorelines positions were delineated through georectification and digitization of historical maps and imagery. The AMBUR (Analyzing Moving Boundaries Using R) package was developed and applied to quantify and visualize changes for each island along the Georgia coast for backbarrier, oceanfront, and inlet-facing shorelines. New transect-casting techniques assist with mapping changes along curved shoreline segments that have proven problematic for traditional perpendicular-transect methods. AMBUR’s output of data tables, graphics, and shapefiles allows for rapid identification of erosion/accretion trends and hotspots in addition to areas of shoreline position fluctuation. Current efforts of shoreline change monitoring along coastal Georgia are focusing on incorporating 3D geospatial data from airborne and terrestrial LiDAR imagery to build a robust 4D GIS database. Currently, a Leica C10 terrestrial laser scanner is being employed to collect 3D imagery of the shorelines along Cumberland Island to assess both 2D (distance & rates) and 3D (volumetric) changes over short and long-term temporal scales. A primary advantage of the Leica C10 scanner is that it permits the delineation of both feature-based (e.g. swash terminus, vegetation edge, bluff toe) and datum-based (e.g. MLLW, MHW, MSL) shoreline positions.

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RESPONSES OF VALLISNERIA AMERICANA TO REPEATED PULSES OF SALINITY

Vallisneria americana strongly influences the ecology of the lower St. Johns River. This dominant species of submerged aquatic vegetation tolerates moderate salinities as documented primarily in studies involving single exposures to salinities of 3–25 for durations of 1–90 d. For example, moderate stress follows exposures to salinities above 15 for 7 d, and a 1 d exposure to salinities of 25 yields extreme stress. In the St. Johns River and elsewhere, V. americana experiences repeated pulses of salinity, but the effects of such exposures have not been documented fully. Two field transplant experiments with potted plants evaluated stress from repeated exposures. In the initial experiment, plants were transported among sites having salinities of < 1, 1, and 15 on three cycles, 3–5, 6–9, and 10–12 d. The second experiment focused on non-stressful salinities, < 1, 4 and 8, with transport on 1, 2 or 3 wk schedules. Experimental plants were evaluated each time they were transported, controls for stress from transport and handling were transported once and assessed on limited occasions, and controls for handling stress were evaluated according to the appropriate schedule without transport. In the first experiment, plants exposed to salinities of > 15 for any duration lost statistically significant numbers of ramets and blades, with no signs of recovery. In the second experiment, plants did not exhibit biologically significant stress associated to exposure to higher salinities, as measured by loss of ramets, loss of blades, increased total antioxidant capacity or increased catalase activity. In combination with results of earlier studies, these experiments predict biologically significant stress and no recovery at salinities around 18 and a lack of significant stress at the individual or physiological levels at salinities < 5 out to 128 d.

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CRITICAL WIND SPEED FOR TURBIDITY RISE IN SOME SHALLOW FLORIDA LAKES

Numerous shallow lakes in peninsular Florida experience high levels of turbidity and nutrient release when high-wind episodes generate waves and circulatory currents. The nutrients are associated with dark bottom muck that is rich in organic matter with low submerged weight compared to clayey muds. Typically the top 0.1–0.3 m thick layer of muck is influenced by wave motion. As nutrient release leads to eutrophication, control of turbidity is a vitally important factor in strategies for restoration of water quality in these lakes. In this paper we have examined the effect of wind on the erodibility of bottom muck in two nominally 2 m deep lakes – Newnans Lake in north Florida and Lake Apopka in central Florida. The type of muck is similar at both lakes. At Newnans Lake, amplitudes of vertical acceleration of muck measured by an accelerometer embedded about 0.2 m below the muck surface indicated that muck began to heave as the wind speed reached a critical value. Pore-pressure amplitudes measured at the same elevation suggested that the effective normal stress of the bed would be zero when the wind reached certain threshold. This symbolizes start of liquefaction which makes the bed more vulnerable to erosion and further increase in turbidity. It is shown that the derived erosion flux as a function of the combined wave-current bed shear stress is also non-linear, and can be modeled by the application of an erosion rate function derived from stochastic representation of wind-induced turbulence in the bottom boundary layer. At each lake year-long time-series of wind, currents, waves, muck pore-pressure, muck acceleration, and suspended sediment concentration (SSC) were collected from fixed platforms, secured to the lake bottom.

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A NUMERICAL MODELING STUDY ON THE EFFECTS OF GEOMORPHOLOGY AND RIVER DISCHARGE ON THE SALT WEDGE OF THE SEOM-JIN RIVER, KOREA

The Seomjin River located in the southern part of Korea is the main habitat of marsh clam, Corbicula. The clam is sensitive to salinity and the salt wedge found in the river is closely related to the population of the clam, and ecology. Since 1970s there has been several civil engineering projects that could modify the salt wedge and subsequently the population of the clam. First, the summer effluence of the river has been decreased substantially due to a dam in the upstream. Second the morphology of the Kwang-Yang Bay, which is located at the mouth of the river, has been changed by reclaing and dredging works. The property of salt wedge depends on mixing that is governed by tide, interfacial shear and local geomorphology and the changes in the geomorphology and/or the discharge could have strong effect on the salt wedge. The principle purpose of this study is quantifying the effects of the changes in the geomorphology and hydrology on the strength of the salt wedge in the Seomjin River. To meet the end we conducted numerical modeling using an unstructured grid ocean circulation model, FVCOM. We also quantified the strength of the salt wedge using a simple scaling theory (a salt wedge length theory) and compared with the model results. We found that change in the coastline modified the circulation in the bay, but did not have strong effect on the strength of the salt wedge in the river compared to the other two factors, change in river effluence and the depth of the river mouth. The weakening of river effluence significantly increases the salt wedge but its contribution is smaller than that due the deepening of the river mouth due to dredging, which allows salty ocean water to travel to farther upstream without much mixing.Acknowledgement: This work was supported by grants from the Ministry of Land, Transport, and Maritime Affairs (Dynamics and prediction of long-term ocean climate variability)
Establishing numeric nutrient criteria in Florida waters has resulted in widely varying views as to how these criteria should be established. Our work on estuarine waters and that of the state and federal regulatory agencies has shown that more questions have emerged than we have necessarily answered. There is a need for clear, unambiguous definition of approaches and analytical techniques if defensible criteria are to be established. There is general consensus that estuaries vary to the point where site-specific criteria are most defensible. The indicator variables are also generally accepted as being healthy seagrasses, balanced phytoplankton biomass and production, and balanced faunal communities. Specifically, chlorophyll, water clarity, and DO are the primary response variables. However, specific endpoints for these variables must be determined. Setting criteria for both N and P is challenging when only one is primarily limiting or when limitation varies seasonally. Whether criteria are more appropriately expressed as loadings or ambient concentrations is also in question. Our results indicate that system-specific criteria are most defensible and that the question of loadings vs. concentrations should be answered by the relative significance of the relationship to chlorophyll. We have found that this relationship differs between drowned river valley estuaries, lagoonal estuaries, and large tidal estuaries. The river to which varying spatial and temporal scales influence the expression of the criteria has also increased. To this end, the statistics best define the criteria remain a question. It is increasingly apparent that “open water” criteria do not apply to tidal creeks as the indicator variables and their endpoints differ from those in the estuary proper. While many interested parties have focused their concerns on the criteria themselves, attention to how compliance with the eventual criteria should not be ignored.

Zostera marina beds in the lower Chesapeake Bay experienced a large scale decline in 2005 and (3) the potential interactive effects of low light and high temperature conditions on bed persistence and resilience. Model projections of Z. marina beds located at the mouth of the York River and independently verified using data measured at a bed located 10 km up river. For both sites, model scenarios were run for three years to quantitatively the effect of (1) the presence or absence of sexual reproduction, (2) projected increases in water temperature from ambient to ambient +5 °C in 1 °C increments, and (3) the potential interactive effects of low light and high temperature conditions on bed persistence and resilience. Model projections of Z. marina production following the 2005 decline and subsequent recovery period were more comparable to in situ measurements when the sexual reproduction component was added to the production model where vegetative growth was the only component of production. In addition, a 1 °C increase in temperature above ambient conditions resulted in a complete loss of Z. marina cover by year three suggesting that temperature stress is a major driver of environmental change in Chesapeake Bay seagrass communities. Therefore, nutrient enrichment in coastal ecosystems is a pervasive anthropogenic stressor resulting in large scale declines in seagrass populations worldwide. Excess nutrient availability often leads to blooms of nuisance algae, smothering seagrasses and attenuating light required for photosynthesis. Excessive inorganic nutrient concentrations (nitrate and ammonium) has also been reported to promote continuous nutrient uptake and assimilation by eelgrass, leading to internal carbon limitation and consequent growth decline. The increasing carbon supply from rising atmospheric CO2 may relieve this carbon drain problem by enhancing the rates of carbon-fixation, thereby positively influencing the internal carbon balance of eelgrass. This essentially translates to increased likelihood of eelgrass survival in eutrophic environments. Despite many evidence for positive feedback on the photosynthetic rates, the long-term effect of elevated [CO2] on eelgrass, especially on the elemental stoichiometry of C and N is still unclear. This study examined the direct influence of long-term CO2 enrichment on (1) nitrogen requirements for maximizing growth, (2) resource allocation to roots and shoots, and (3) the effects on the C and N content of the temperate eelgrass Zostera marina L. using an empirical model and laboratory measurements. Resulting shifts in C and N content of leaves may have a significant impact on higher trophic levels that rely on eelgrass.

Fine-grained suspended solids and sediments are viewed as two leading sources of pollutants in rivers and estuaries since they carry pesticides, PCBs, and nutrients. Mechanistic and empirical models are accepted as effective tools for TMDL development and implementation, and evaluating performances of Best Management Practices (BMP). The selection of the right model requires a thorough understanding of the capabilities and limitations of available models. This paper evaluates and summarizes some of the essential features of the widely used hydraulic, hydrodynamic, and water quality models with the emphasis on TMDLs and BMPs. Water quality models, specifically those that can simulate sediment transport and fate of sediments closely related to the presence of pesticides, PCBs, and nutrients. For urban areas SWMM, and for mixed land uses, i.e. rural and urban, HSPF are suitable watershed loading models that can be potentially used with hydrodynamic and water quality models for TMDL analysis and BMP development. The primary sources of these fine-grained particles include urban and non-urban uplands, bank erosion, atmospheric deposition, shoreline erosion, etc. This paper also quantifies the efficiency of fine sediment BMPs, and to explore methods whereby their efficiency can be maximized. A three-dimensional hydrodynamic and sediment transport model has been applied to a river or estuary to assess the effectiveness of Best Management practices, such as, sedimentation ponds and sediment traps. The traps can be used as partial remediation alternative to reduce the transport of contaminated sediments from a river to the estuary. The off-channel traps would consist of sedimentation ponds, with water being diverted from the river into the ponds. The in-channel traps were represented as cut channels along the river.

Oxygen Deficient Zones (ODZ), we analyzed DNA samples and present data from some of these hotspots that include the seasonally occurring Coastal Arabian Sea (AS), open ocean AS and ETSP. Diversity was evaluated using miR and miR genes for denitrifiers and the 16S rRNA gene for anammox bacteria. The miR genes from the AS are not closely related to each other published sequences, but the closest identities are with sequences from other water column denitrifying environments. Phylogenetic analysis of the miR shows that the overall denitrifier diversity is high in the AS, while that of the anammox 16S rRNA is considerably lower and was represented by a single type. Based on Q-PCR assays of miR, miK (denitrifiers) and anammox 16S rRNA gene abundance, we found that denitrifiers greatly exceeded anammox bacteria in both the AS and the ETSP upwelling region. Even at stations where anammox rates are high, anammox abundance and diversity was very low and ranged from 2 to 12 % of the total miR abundance. These gene abundances imply that denitrifying and anammox bacteria represent a variable proportion of the total microbial community, and both were undetectable in surface waters.
LINKING HUMAN DIMENSIONS AND ECOSYSTEM VALUES INTO INTEGRATED CONCEPTUAL ECOSYSTEM MODELS TO BENEFIT ECOSYSTEM MANAGEMENT

This presentation will describe how human dimensions and ecosystem values are incorporated into an Integrated Conceptual Ecosystem model (ICEM) of the Florida Keys–Dry Tortugas marine ecosystem (FK-DT). This model was developed during the MARES project, a NOAA funded collaborative effort between academic, government, and private organizations; biological and social scientists and resource managers to characterize South Florida coastal marine ecosystems. The Florida Keys ICEM organizes scientific and social information to assist managers in identifying ecosystem problems, setting management goals, prioritizing management actions, and assessing environmental response. The human dimensions component links human values and responses associated with ecosystem services and management actions. Environmental attributes are a parsimonious subset of all potential components of the marine environment that represent its overall condition. These attributes and the environmental components they address provide ecosystem services that are valued by humans. Ecosystem services are identified by considering the "attributes that people care about." Unlike environmental attributes, ecosystem services have direct value to humans that can be measured in dollars or another meaningful measure. Economic valuation tools provide monetary measures of ecosystem services that reflect human willingness to pay to maintain or improve these services. Trends in ecosystem service values can be used to identify ecosystem components in need of attention. This presentation will focus on the Water Quality Submodel of the FK-DT ICEM. Topics to be covered include: defining and identifying ecosystem services and how they relate to attributes that people care about; how to value ecosystem services and select meaningful human dimensions indicators. The presentation will provide examples of relevant value statements that have been estimated in the past and how they benefit policy and management decisions.

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Orchestra grullus (amphipod), and Melampus bidentatus (gastropod). Animals were fed Spartina patens litter from a tidal creek that had been nutrient enriched for 7 years or from a reference creek. Here, non-linear richness effects and compositional effects were detected on litter-mass loss; no nutrient effects were detected. These results suggest that detritivores can be important in the decomposition of marsh litter and that watershed-level activities such as nutrient pollution can influence the functioning of estuarine-linked habitats.

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SPATIAL MANAGEMENT OF AN ESTUARINE CRUSTACEAN: INTEGRATION OF STAKEHOLDER PARTICIPATORY RESEARCH AND FISHERY DATA TO INFORM POLICY DECISIONS

Marine spatial planning, including spatial and temporal closures, is an increasingly utilized approach to fishery management, particularly for species whose distributions are predictable in time and space. The effectiveness of spatial management approaches for conservation and sustainability of coastal fisheries can only be evaluated with a detailed understanding of the spatial dynamics, movement patterns and population connectivity of a fishery stock. We worked cooperatively with local watermen and fishery managers to conduct a mark-recapture study to quantify the spatiotemporal distribution of mature female blue crabs (Callinectes sapidus) during the annual fall migration period in the Potomac River, USA. The data was integrated with existing fishery-dependent data on harvest and effort to evaluate four spatiotemporal closure options under consideration by regional managers that were designed to reduce exploitation of mature female blue crabs. Specifically, we evaluated the effectiveness of each management option with respect to three criteria (1) effectiveness (magnitude of reduction in annual mature female blue crab harvest), (2) consistency (the variability of annual harvest reductions among years), and (3) equitability (the extent to which harvest reductions were evenly distributed across fishers within the management jurisdiction). Our analysis was further integrated with consideration of human dimensions (socioeconomics, enforcement) during public stakeholder meetings with managers, scientists, and fishermen. This case study highlights (1) the critical role of rigorous scientific data in underpinning management and policy decisions (2) the value of combining directed field experiments with long-term fishery-dependent data streams, and (3) the importance of active stakeholder involvement in research activities.

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SURFACE WATER METABOLISM POTENTIAL OF GROUNDWATER-FED NEAR SHORE WATERS ON THE LEEWARD COAST OF THE ISLAND OF HAWAII

Submarine groundwater discharge (SGD) has become increasingly recognized as an important source of freshwater and nutrients to coastal waters worldwide. Although groundwater nutrients have been found to cause algal blooms in many temperate coastal waters, little is known about the biological response to these nutritional inputs in tropical environments. On the leeward coast of Hawaii Island, SGD is the dominant freshwater and nutrient source to coastal waters. Kiholo Bay and Kaloko-Honokohau are two nearshore regions with well-documented SGD with high nutrient concentrations; however, little is known about how biological processes within the water column respond to these inputs. This study examined how gross primary production (GPP), respiration (RESP), and metabolism (MET) within surface waters differed inside and outside of groundwater plumes at these two sites. Overall, surface waters at both sites were generally heterotrophic, with RESP being greater than GPP. However, both GPP and RESP were significantly higher within groundwater plumes. Results from our study suggest that groundwater nutrients are stimulating biological processes in these coastal waters, but RESP more so than GPP, making these surface waters heterotrophic, and net sources for atmospheric CO2, a pattern that contrasts from temperate systems.

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VALIDATING THE CHESAPEAKE BAY PHYTOPLANKTON INTEGRITY INDEX OF BIOTIC INTEGRITY WITH RECENT DATA

In 2006, a phytoplankton index of biotic integrity (PIBI) was released for Chesapeake Bay (Lacouette et al. 2006). The PIBI was developed from data collected during the first 18 yr (1985–2002) of the Chesapeake Bay Water Quality Monitoring Program. Combinations of twelve metrics were selected to characterize plankton community condition across habitat conditions defined by nutrient and light availability, in 2 season and 4 salinity zones. The independent data available at the time for index validation was not sufficient to test the PIBI because they lacked critical index parameters (phosphate and dissolved organic carbon) and reference samples for some seasons and salinity zones. The Chesapeake Bay Phytoplankton and Water Quality monitoring programs have continued through the end of calendar 2010 in
some capacity. There is now an additional eighty-year block of monitoring data (2003-2010) available to independently validate the original index, reassess index performance and examine long-term trends in PBII conditions in the Bay. Further evaluation of the PBII over the entire 1985-2010 time period has shown a continued decline in the overall health of Bay phytoplankton communities as overall water quality conditions-and particularly light availability-have continued to decline. The index continues to show a strong relationship between water quality, the influence of flow and PBII scores.

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IT'S NOT YOUR FATHER'S TABS/MA MODEL ANYMORE

The RMA2 and RMA4 hydrodynamic and transport models that were originally developed in the 1970’s for the US Army Corps of Engineers (Corps) and were released as the TABS system of models have undergone subsequent development by the Corps. However, in recent years the RMA2 and RMA4 models have been modified outside the Corps by one of the original model developers, Dr. Ian King of Resource Modelling Associates, such that simulations for very large-scale problems (thousands of square miles) for long durations (several years) have been performed on standalone personal computers for evaluating coastal restoration projects in coastal Louisiana. This presentation describes the changes that have been made to make the model applicable and feasible to run and presents some results from the case studies for several such systems.

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INTEGRATING CORAL REEF BLEACHING RESILIENCE INTO MANAGEMENT STRATEGIES FOR FLORIDA'S CORAL REEFS

The Florida Reef Resilience Program (FRRP) is a collaborative effort among managers, scientists, conservations organizations and reef users to develop resilience based management strategies for coping with climate change and other stresses on Florida’s coral reefs. Since 2005, The Nature Conservancy has coordinated a Disturbance Response Monitoring (DRM) effort, consisting of a probabilistic sampling design and a stony coral condition monitoring protocol, implemented during peak thermal stress across the entire South Florida reef tract that extends from Martin County to the Dry Tortugas. Each year, 13 teams from federal, state, and local government agencies, non-profit organizations, and universities completed surveys across the entire South Florida reef tract within a six to eight week period. Sample sites were stratified randomly, allowing information gathered on the coral population’s size frequency, size structure, and bleaching prevalence to be extrapolated for different sub-regions and zones. Results from these surveys show spatial and temporal patterns in coral bleaching and colony size frequency distribution, indicating that some reef areas or coral species may be more resilient to stress than others. A cold water event in January 2010 initiated a winter DRM response and has provided new data results and insight as to which reef areas and coral species may be more resilient to cold water versus warm water stresses. While the causes of the bleaching variability remains poorly quantified, projected increases in coral bleaching due to climate change makes identification of these resilient reef areas and species important for long-term coral reef conservation and future management strategies.

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PRELIMINARY RESULTS FROM A MESOCOSM MARSH EXPERIMENT WITH TREATMENTS SIMULATING THREE TIDAL FLOODING AND PRECIPITATION CONDITIONS

Our goal was to observe and quantify the effects of low, medium and high tidal flooding regimes and various precipitation conditions on both Spartina alterniflora and Typha angustifolia in laboratory mesocosms. The experiment was maintained for 4 months. Each of 3 tanks (600L) had simulated seawater tidal rise and fall over two cycles daily; each tank contained pots on shelves at 3 heights; tanks received freshwater input which simulated either drought, ambient rain or storm conditions. The drought tank received no freshwater, the storm tank received freshwater biweekly which increased the tank water level by 10cm, and the ambient rain tank received freshwater daily which increased the tank water level by 3.25mm. Each tank contained pots of soil composed of sieved peat, compost and sand at ratios of 2:1:0.125. Half the pots were planted with Spartina (n=3) and the other half with Typha (n=3). Here we present data for porewater sulfides, salinity and pH and preliminary soil respiration in both the Spartina and Typha pots. No sulfides were found in the porewater throughout the experiment. A two-way ANOVA was used to test for precipitation and tidal flooding effects as well as precipitation X flooding interactions on the porewater salinity and pH for each plant species. The main effect of precipitation on Spartina was significant for porewater salinity and porewater pH. The tidal flooding effect on porewater pH in Spartina was also significant, but there were no flooding effects on porewater salinity. The main effects of precipitation and tidal flooding and their interaction on Typha porewater were significant. The drought tank under low flooding conditions showed lower pH and higher salinity than the other two treatment tanks; this could have an effect on plant vitality. Changes in pH and salinity are important to understand in order to model effects of sea level rise and climate change on marsh grass.

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MONITORING AN URBAN WETLAND: PAST, PRESENT, AND FUTURE VEGETATION

The Ballona Wetlands Ecological Reserve (BWER) is the largest opportunity for wetland restoration in the Santa Monica Bay and Los Angeles County. The Santa Monica Bay Restoration Commission (SMBRC) has been collecting baseline biological data at the BWER in Los Angeles, California, for several years. The project objective is to increase knowledge of the health and functioning of the BWER to inform an adaptive management and long-term restoration plan, while developing reproducible, scientifically valid regional wetland monitoring protocols. The vegetation alliances of the BWER have undergone significant shifts in the past several decades, including massive impacts such as the development of Marina del Rey and the subsequent placement of fill on site in the late 1950’s, and smaller scale events such as non-native plant invasions or community restoration efforts. The goal of this paper is to recognize some of the larger impacts, discuss shifts over time using current data, and to assist in the adaptive management planning of the restoration process. The current status of the vegetation was assessed using a stratified random sampling method; transects were randomly allocated within each of the habitat types at the BWER. Species level data were collected in addition to elevation and inundation information along the same transects. Percent native cover was negatively correlated with elevation; percent non-native cover was positively correlated with elevation. Inundated areas had the lowest non-native cover. Salicornia virginica cover was also negatively correlated with elevation. Elevation, native cover, and non-native cover were significantly different between habitat types. Several of the marsh zones previously thought distinct may be similar based on vegetative cover. The implications of the results may help to reassess habitat zones and priorities for the future marsh restoration.

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EUTROPHICATION AND RECOVERY IN THE TIDAL FRESHWATER POTOMAC RIVER: GUNSTON COVE AND OTHER STORIES

The tidal freshwater Potomac River received extensive loads of wastewater nutrients through much of the 20th century, culminating in major blooms of cyanobacteria and almost total loss of submerged aquatic vegetation (SAV). Beginning in the late 1970’s, loads of the limiting nutrient, phosphorus, underwent dramatic reductions which decreased loadings by more than 98%. Long-term trends in water quality, phytoplankton, and SAV in Gunston Cove, a shallow embayment of the tidal freshwater Potomac River receiving treated wastewater, and in the adjacent river have been monitored on a consistent semimonthly basis since 1983. Episodic monitoring data is available for periods back to the mid-1960’s, allowing construction of a data record spanning the time from intense loading and eutrophication through the nutrient load reductions of the late 1970’s and early 1980’s and continuing to the present. Response to nutrient loading was not immediate, partially because even at reduced levels nutrients were not generally limiting. But following a lag period of over a decade, nutrient concentrations and phytoplankton populations have shown a steady decline and water clarity has demonstrated marked improvement. In recent years SAV has spread over larger portions of the embayment, consistent with model predictions of macrophyte recovery. The state of the Cove could now be characterized as partially recovered, with SAV returning to shallower inner areas of the cove, but not able to successfully colonize the somewhat deeper mid to outer cove. The adjacent river channel appears to be on a similar, albeit more gradual, restoration trajectory. This likely reflects hysteresis in response to both local and basin-wide nutrient management over the same period. Results demonstrate the role of time lags in ecosystem response and the importance of long-term monitoring in understanding ecosystem recovery.
SUSTAINABILITY RESEARCH SUPPORTING GULF OF MEXICO ECOSYSTEM RESTORATION: EPA’S OFFICE OF RESEARCH AND DEVELOPMENT

The Gulf Ecosystem Restoration Task Force was formed by Executive Order, October 2010. The Task Force leads and coordinates research in support of ecosystem restoration planning and decision-making in the Gulf Coast region. In support of a comprehensive restoration strategy, research in EPA’s Office of Research and Development (ORD) is strongly aligned with the principles of ecosystem restoration in the Gulf Coast region. The goal of ORD’s Sustainable and Healthy Communities Research Program (SHCRP) is to empower decision-makers to integrate human health, socio-economic, environmental, and ecological factors to foster sustainability in the built and natural environments. As an element of SHCRP, the rapid deployment of coral reef management and public health officials.

The likelihood of detecting sewage contamination events. This approach will greatly inform both Sewage-associated microorganisms that cause a devastating coral disease. Combining the samples alone, and can be tailored for specific threats, such as Serratia marcescens, a human pathogen in the water column, and to guide restoration and decision-making. We describe how this research has yielded new insights into the processes that contribute to hypoxia, thereby improving predictions of the effects of watershed nutrient load reduction scenarios.

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OPEN OCEAN IMPACTS OF THE MACONDO OIL WELL BLOWOUT

The explosion and subsequent sinking of the Deepwater Horizon drilling rig resulted in a massive deepwater blowout that injected vast quantities of crude oil and hydrocarbon gases like methane into Gulf of Mexico. The depth of the blowout (~1500m), the magnitude of oil and gas injection, and the duration of the event (~84 days) underscore the unprecedented nature of this environmental disaster. Some of the oil released and essentially all of the gas (methane to pentane) was trapped in extensive undersea plumes. These plumes occupied layers of varying thickness between 800 and 1300m water depth. Very little gas appears to have fluxed to the atmosphere early in the incident, but atmospheric loss may have been important later. The injection of hydrocarbons into undersea plumes generated a swift microbial response (e.g. changes in microbial community structure) to guide restoration and decision-making. We describe how this research has yielded new insights into the processes that contribute to hypoxia, thereby improving predictions of the effects of watershed nutrient load reduction scenarios.

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MARINE SPONGES AS POTENTIAL RESERVOIRS FOR ENTERIC BACTERIA AND IMPLICATIONS TO HUMAN AND CORAL HEALTH

Sewage contamination of coastal marine waters is a threat to both human and environmental health. There is a broad search for sentinel species to detect contamination events. Current sampling methodologies do not accurately represent human bacteria and viruses within the environment and a multiple scale approach may be necessary. Such an approach could be to focus on an animal that would be a good sentinel for exposure as well as bacteria that are commonly found in sewage water. Marine sponges are common in almost all marine habitats; therefore their habitat diversity contributes to the hypothesis that they may be good sentinel organisms. Additionally, sponges filter feed and may concentrate ambient microbes without discriminating between naturally present microbes and those introduced through sewage contamination. Screening sponge tissue for enteric bacteria and indicators may provide more information about contamination events than using water samples alone, and can be tailored for specific threats, such as Serratia marcescens, a sewage-associated bacteria that causes a devastating coral disease. Combining the sampling approach of collecting sponge tissue and screening the tissue for traditional fecal indicators as well as S. marcescens improves the power of sampling and increases the likelihood of detecting sewage contamination events. This approach will greatly inform both the coral reef managers as well as public health officials.

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AN INTEGRATED TOOL FOR COMPLEMENTARY ASSESSMENT OF ESTUARINE FUNCTIONING ACCORDING TO THE HABITAT DIRECTIVE

In agreement with the current environmental conservation policies, the management of protected areas tends to assess the status of their protected habitats and species. However, the actual management of these areas needs a complementary assessment of the environment in which habitats and species are developed. In this sense, several methods have been developed for the assessment of the structural features of aquatic ecosystems (e.g. methods for the ecological status assessment, Water Framework Directive). But these methods do not cover functional aspects. In the present study we present a methodology to assess the estuarine integrity as an ecosystem functioning assessment, taking into account the main physical and biological processes which guarantee the ecological coherence of these areas. The methodology is based on three assessment elements: i) hydrodynamic and hydrologic processes (e.g. tidal dynamics, estuarine connectivity and river inputs), ii) geomorphologic processes (e.g. changes in morphology, and associated erosion and sedimentation), and iii) estuarine biological structure (e.g. saltmarsh and seagrass status - as primary producers; benthic communities status - as secondary producers). This methodology has been applied to nine estuaries, which highlighted problems related to the quantity and quality of water and sediment flows, and nutrient enrichment.

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MODELING THE PRODUCTION OF SALT MARSH GRASSES: ENVIRONMENTAL FACTORS AND ELEVATION

Salt marsh grasses species change as one moves from high marsh areas to low marsh areas as a result of many factors including light, salinity and nutrient availability. We are developing a model to understand the factors controlling species succession from high marsh to low marsh, using data from the Georgia Coastal Ecosystems Long Term Ecological Research program at Sapelo Island. We present results from initial development of the model and comparisons of model output with long-term data. The development and accuracy of the model depends crucially on the availability of data, which is not uniform across the species being studied (Spartina alterniflora, Juncus Roemerianus and Borrichia Frutescens). We discuss future developments and uses of the model.

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THE SOUTHEAST FLORIDA CLIMATE CHANGE COMPACT - A COORDINATED APPROACH TO ADDRESSING CLIMATE CHANGE pressures AT THE REGIONAL LEVEL

On October 23, 2009, Broward, Monroe, Miami-Dade and Palm Beach Counties coordinated to host the first annual Southeast Florida Regional Climate Leadership Summit as a means of convening elected leadership to discuss the shared challenges that climate change poses for the region and to seek a coordinated planning approach. A product of the Summit was the Regional Climate Change Compact, committing each county to partner in climate policy and planning efforts, and the development of a regional climate action plan. Staff has formed a working Steering Committee with representation from each of the Compact Counties and the South Florida Water Management District as an invited partner. The Climate Leadership Initiative (CLI) provides assistance to the planning process as part of its national climate preparedness program while Florida Atlantic University’s Climate and Energy Program and ICLEI have also played a supporting role. By working collaboratively at the regional level, the Counties have sought to enhance our individual efforts to mitigate emissions while working to actively incorporate adaptation strategies into the regional action plan. Partners
have worked cooperatively with regional and national entities to implement the Compact’s objectives, including development of regionally-consistent methodologies for inundation mapping and vulnerability assessments, a regional greenhouse gas emissions inventory, a unified sea level rise projection, and joint policy positions on climate change. Three regional work groups have been formed to develop priority recommendations in the areas of natural systems and lands, built environment, and transportation as part of the regional action plan to be presented at the 3rd Annual Southeast Florida Climate Leadership Summit in October 2012.

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TRANSPORT, STRUCTURE, AND MIXING OF A BUOYANT RIVER PLUME SUBJECTED TO VARIABLE CROSS SHORE WINDS

Idealized model simulations are carried out examining the effect of cross shore winds on a buoyant river plume system. For an offshore wind case the plume is transported offshore where it reached quasi-equilibrium in relation to the freshwater discharged from the estuary and the freshwater transport in the plume. The plume resembles an elongated barocline eddy which is modified by the offshore wind stress, with strong downstream transport on the offshore portion of the plume and weak upstream transport near shore. This is driven by a cross shore momentum balance between the total pressure gradient, coriolis, and the vertical stress divergence. The freshwater transport in the plume can be decomposed into an EkmAn driven component and a cross-shore pressure gradient driven component. Immediately following the onset of the offshore wind stress, the transport is dominated by the Ekman processes. During this time a simple formulation for the plume width is achieved by using the freshwater transport in the plume and formulations of the plume averaged depth and salinity. This simple scaling begins to fail once the cross-shore pressure gradient develops, which leads to an asymmetric along shore velocity structure within the plume. However, the timescale of adjustment for the pressure driven flow falls within the meteorological forcing band of 3-5 days, yielding a potentially useful tool to analyze the response of a plume’s structure to offshore winds in realistic settings. The role mixing in determining plume structure is also addressed. When transport is dominated by Ekman processes, strong vertical mixing occurs over a broad section of the plume, while the high vertical mixing is concentrated on the offshore portion of the plume after the pressure gradient develops.

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RANDOM WALKS IN THE DEAD ZONE: COUPLING 3-D HYPOXIA MODELS WITH INDIVIDUAL BASED FISH MODELS

In recent years, modeling has emerged as a major research tool to study dynamics of hypoxia and predict system responses to variations in climate and anthropogenic nutrient loading. Advances in three-dimensional coupled hydrodynamic-biological models have allowed representation of short-term oxygen variability over an entire bay or shelf/hypoxic region so that the critical roles of local biology, wind and buoyancy forcing can be examined. At the same time, modeling of regional impacts of hypoxia on fish populations has been fairly limited. In particular, there has been little attention to derive exposure histories of simulated fish populations or to explain large-scale fish movement patterns in response to changing oxygen concentrations. To address this problem, we have coupled a high-resolution, three-dimensional, unstructured-grid, Finite Volume Coastal Ocean Model (FVCOM) with Water Quality Analysis Simulation Program (WASP5) and an Individual Based Fish Model (IBM). The coupled models were implemented to simulate the seasonally hypoxic region of the Louisiana-Texas shelf. We used the models to investigate how different behavioral movement approaches (e.g., kinesis versus fitness, degree of avoidance) and temporally- and spatially-dynamic hypoxia conditions can affect fish distributions and the exposure histories of individual fish. Our initial results suggest that the degree of avoidance assumed plays a major role in affecting exposures, regardless of the behavioral algorithm used for movement, and that the time histories of individual-level exposures are complex and difficult to capture with examination of the average fish.

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OPERATIONAL MODELLING OF ALGAL BLOOM FOR EARLY WARNING OF RISKS

Algal blooms and in particular toxic algae blooms pose a serious threat to marine aquaculture worldwide. To the Danish Aquaculture industry, especially toxic blooms of *Pseudonovellula farcimen* in the spring has for the last 12 years posed a serious economic risk. To deal with the threat, the fish farming industry has traditionally collected water samples and analysed these for occurrences of toxic algae. This strategy does however always involve a delay; i.e. the information is history because of time spend on sampling and analysis. Furthermore this approach does not give prognoses of the development in the coming period. Therefore a new algal risk assessment concept has been developed combining the in situ sampling with operational 3D dynamic modelling of the hydrographical conditions and the growth and transport of planktonic algae. The applied ecosystem model (MIKesyDH3D FM; combined with ECO-Lab ecosystem model) covers all Danish marine waters model and includes more functional algal groups as well as two functional zooplankton groups. Earth observation of chlorophyll is assimilated into the model and this has shown to improve the validity of the model output significantly. All data is published on a web site comprising as well an algal risk bulletin and data usable in daily operation of fish farms. The presentation will describe the early warning algal risk system and discuss performance of the included model and calls for further developments.

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THE EFFECT OF DEEP WATER HORIZON OIL ON OXYGEN CONSUMPTION IN NORTH FLORIDA BEACHES

In June 2010, large amounts of Deep Water Horizon oil was washed up onto Pensacola beaches and buried as deep as 70 cm in the sediment. Our project investigates the fate of the embedded oil and its impact on sediment biogeochemistry and microbiology. Cores of sand were taken monthly from Pensacola beach, Florida, and analyzed for oxygen consumption/DIC production and bacterial community changes. Sediment layers with oil showed potential oxygen consumption rates increased up to 7 times the consumption rates of clean layers in the same sediment. Most growth and metabolic activity in the oil layer showed oxygen consumption rates similar to clean layers further removed from the oil layer, indicating a localized impact of the concentrated oil and a lack of movement once the layer was embedded within the sediment. The increased oxygen consumption in the oil layer changed biogeochemical characteristics of the typically organic-rich beach sand, leading to the layers with reduced oxygen availability and mobilization of iron.

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PHYTOPLANKTON PRODUCTIVITY IN THE SURF ZONE OF SANDY BEACHES ESTIMATED BY SIMULTANEOUS IN SITU 14C INCUBATIONS AND FAST REPETITION RATE FLUOREOMETRY

Measurements of primary production in surf zone habitats are relatively rare and often utilise simulated in situ approaches, owing to the physical challenges of working in surf. The study reported here examined primary production at two open ocean beaches in southeastern North Carolina during relatively calmer summer conditions. In situ bottle incubations using 14C uptake methods were complemented by simultaneous measures of phytoplankton productivity assessed by Fast Repetition Rate Fluorometry in flow-through mode at two beach sites across one spring-neap tidal cycle in July, 2010. The surf zone phytoplankton was dominated by small centric and pennate diatoms as well as cyanobacteria and chlorophytes with biomass concentrations of 3.63 – 9.23 mg chl a m-3. Primary productivity measured by both techniques was relatively high, ranging from 31.5 – 88.0 mg C m-3 h-1 by 14C and somewhat higher, as expected, by FRRF. Biomass-specific productivity averaged 9.4 C mg chl a-1 h-1, indicating healthy phytoplankton populations. These data suggest that the surf zone, although a spatially confined habitat, is a productive one that plays a significant role in coastal ocean ecology.

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EFFECT OF MULTIPLE STRESSORS ON EELGRASS ZOSTERA MARINA L. FROM THE PACIFIC NORTHWEST, USA: MANIPULATION OF TEMPERATURE AND NUTRIENTS

Estuarine eelgrass beds in the Pacific Northwest (PNW) are being exposed to a range of natural and anthropogenic stressors and climate change. The purpose of the current study was to examine the effects of temperature and nutrient quantity on *Z. marina* growth and physiology. Manipulations were conducted in acrylic chambers and spanned a range of temperature and nutrient concentrations. Single factor range finding experiments were conducted to evaluate physiological tolerances to temperature and nitrogen concentrations. Eelgrass exhibited a significant, linear increase in specific growth with increasing NH4 from 0 to 1000 μM; there was no relationship between specific growth rate and NO3 over the same concentration range. Leaf growth and specific growth all exhibited strong linear relationships with increasing water temperature (range 4-25 °C). The factorial experiment used 3 temperatures (10, 18 and 25°C) and 3 nitrate concentrations (10, 30 and 100 μM) with 2 replicate chambers per treatment combination. Most growth and below the mud exhibited a significant temperature effect indicating the importance of temperature on metabolic rates. Tissue δ15N and C:N values generally exhibited a significant nutrient effect and in some cases a significant temperature effect. Non-structural carbohydrate content of eelgrass exhibited no significant differences with respect to either temperature or nitrate.
concentration. The results indicate that Z. marina in the PNW may be insensitive to high N, but extremely sensitive to increased temperatures. The results also suggest that increased temperatures may predispose Z. marina to secondary stressors such as wasting disease, potentially impacting estuarine seagrass beds.

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THE QnD SIMULATION MODEL AS A TOOL FOR ADAPTIVELY MANAGING HUMAN-ENVIRONMENT INTERACTIONS

This paper reports on simulation modeling as an adaptive management tool at the local scale. It focuses on the use of an object-oriented model known as QnD (Question and Decisions) for managing human disturbance of critical nesting habitat for least terns (Sterna antillarum) at Botany Bay Plantation, in South Carolina’s ACE Basin. The site, which opened to the public in July 2008, has no baseline data and few management resources. The QnD model addresses this level of uncertainty by allowing end users to define different sets of system variables and to use these alternative versions of the system for exploring scenarios and management options. This paper looks at early-stage results of this process and examines the potential for developing a replicable method for connecting and coordinating local adaptive management programs.

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ADDRESSING CLIMATE CHANGE IN THE SARASOTA BAY NEP REGION

Sarasota Bay is one of 28 National Estuary Programs in the United States that has been named by the U.S. Congress as an “estuary of national significance.” In the fall of 2010, the Sarasota Bay Estuary Program (SBEP) was awarded a grant from the United States Environmental Protection Agency/Climate Ready Estuaries Program (EPA/CRE) to support sea level rise (SLR) adaptation in the SBEP region. SBEP has partnered with Mote Marine Laboratory’s Marine Policy Institute (MPI) for implementation of this project. This collaborative partnership builds on initial policy tools for local SLR adaptation work done by MPI and advances the SBEP mission. The field of climate change adaptation is poorly defined and rapidly evolving. Policy makers, scientists and concerned citizen groups in many communities across the nation are experimenting with creative approaches to this problem. A SLR web visualization tool was developed using Light Detection and Ranging (LIDAR) data for the SBEP region by EPA contractors with advice and feedback from the SBEP project team. The visualization tool was introduced to local leaders, government staff, and interested citizens as a first step for increasing awareness and knowledge about local sea level rise impacts and the importance of long-range adaptation planning. The SLR tool is providing valuable experience and education on the challenges of introducing basic climate change science into the entire community. It has provided important early insights for community awareness and how to introduce the SLR tool. The SBEP will continue to work with Climate Ready Estuary partners and NOAA to share information and collaborate on future projects.

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EMERGY EVALUATION OF THE YOUNGSAN RIVER ESTUARY IN KOREA

The emergy methodology was used to evaluate the contributions of the Youngsan River estuary located in the southwestern coast of Korea to its economy. The system boundary for the emergy evaluation adopted the marine section of the management area suggested in a previous study intended to establish a management framework for the estuary. Renewable resources provided a total of 1.03 x 10^12 ergs of emergy to the estuary in 2006. The macroeconomic value (envalue) of this input was calculated as 308.2 million em$/yr (or 25.550 em$/ha/yr). The chemical energy of inflowing rivers and streams accounted for 69% of the emergy input followed by tidal energy (31%). This reflects the unique environmental characteristics of the estuary where rivers meet sea. The tidal flat ecosystem of the Youngsan River estuary received a total of 4.75 x 10^12 ergs/yr with an envalue of 142.5 million em$/yr. Four services of the Youngsan River estuary were evaluated with the emergy methodology: fishery production, pollutant (nitrogen) removal, aesthetic value, and scientific research information. Aesthetic value contributed the most to the Korean economy with 308.2 em$/yr, followed by fishery production (63.5 million em$/yr), pollutant removal (59.9 million em$/yr), and scientific research information (7.4 million em$/yr). For the fishery production with statistical data, the emergy contribution was about 4.5 times greater than the monetary value (14.0 million USD in 2006) of the fishery products harvested in the estuary. The emergy evaluation showed a need for methodologies that approach the valuation of ecosystem services in different perspectives to establish successful policies to utilize the ecosystem services of the Youngsan River estuary in a sustainable way.

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RESPONSIVE OIL SPILL OUTREACH BASED IN SCIENCE

Collaborators from University of Southern Mississippi, Mississippi Public Broadcasting, Mississippi State University and the Center for Ocean Sciences Education Excellence Central Gulf of Mexico received a National Science Foundation Rapid grant to produce responsive, multi-media outreach to the general public regarding the oil spill in the Gulf of Mexico that started with the Deepwater Horizon explosion April 20, 2010. In the days and months after the oil spill, there was an abundance of misinformation and poorly interpreted information available to the public; no clear path was available to provide members of the public with accurate information. This project was designed to provide basic and credible information regarding the Gulf of Mexico, oil production and the habitats that were impacted by oil. This effort addressed specific misconceptions on a topic-by-topic basis via each objective with the goal of guiding the audience to a better understanding of data collection, analysis and interpretation as well as the role of science and scientific knowledge in making decisions during a crisis and policy after catastrophes. Three one-hour television programs were broadcast in August, September and November 2011. Each included two to three videos that addressed one of the complex topics related to the oil spill using basic, accessible terminology. The videos lasted 3-6 minutes and were used to focus the roundtable discussion of a panel of scientists who provided additional context regarding each topic. The companion Web page, SplitScience.com, accessible via the COSEE COOM Web site (http://cosee-central-gom.org), is moderated and includes full programs, additional video interviews and blogs from scientists and well as frequently asked questions (with answers) and a selection of accurate resources, annotated to help page users find additional information.

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AREAS OF SEAGRASS LOSS AND STABLE COVERAGE: DO FINE-SCALE MAPS OF PATCH DYNAMICS AGREE WITH TRENDS DETECTED BY LARGER SCALE ASSESSMENTS?

Geographic Information System (GIS) based seagrass maps are produced by the Southwest Florida Water Management District (SWFWMD) to document seagrass areal extent and distribution within Gulf coast estuaries, including Tampa Bay. Aerial mapping techniques continue to document that Tampa Bay have documented estuary-wide increases in seagrass area, but have also detected dynamic areas within the bay displaying decreasing cover. In general, SWFWMD mapping protocol relies on observing seagrass signatures at a macro-scale over a large extent, using a minimum mapping unit (MMU) of 0.2 ha. An independent study was conducted to create fine-scale maps for a subset of seagrass landscapes in Tampa Bay to examine if these detected changes in landscapes where large-scale loss is occurring. Using GIS processing tools, a random population of SWFWMD map polygons, 2 ha or
smaller, displaying either decreasing or stable coverage in 2008, was selected for evaluation. Visualizing the imagery on-screen at a scale of 1:1,580 and using an MMU of 5 m², each selected landscape was mapped for the years 2004, 2006, and 2008. Landscapes, originally classified as those with declining seagrass coverage based on SWFWMD protocol, were also evaluated as displaying patterns of loss when analyzed at finer resolution. Specifically, decreases in percent cover of seagrass for the fine-scale study ranged from 16% to 82%. Most landscapes with declining seagrass patch area also displayed an increasing number of seagrass patches. For areas defined as stable, more than 50% of landscapes were found to increase in percent seagrass cover at the end of three years, with increases ranging from 10% to 45%. Thus, we found SWFWMD’s protocol and this fine-scale study to agree for areas of increase in percent seagrass cover at the end of three years, with increases ranging from 10% to 45%. This implies that fine scale mapping may increase the ability to detect and quantify internal landscape dynamics and detailed patterns of patch expansion or contraction.

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ASSESSING ATTAINMENT OF WATER QUALITY STANDARDS UNDER SIMULATED NUTRIENT LOADING SCENARIOS

The assessment of estuarine response to simulated load reductions was a key component of the development of the Chesapeake Bay Total Maximum Daily Load (TMDL). Here we demonstrate the successful application of a novel method for determining Water Quality Standards (WQS) attainment under simulated nutrient load reductions. In order to determine the load reductions required to attain WQS, we used a suite of watershed and estuarine water quality models to estimate the magnitude of change in key estuarine water quality indicators (e.g. dissolved oxygen, chlorophyll a) under various nutrient loading scenarios. We applied these simulated estimates of response to historical observations of water quality. We then assessed the resulting projected conditions using the same methods by which one would conduct a 303(d) listing assessment. The utility of a method that uses simulated responses of key indicators to modify historical observations is shown. Evaluation of the results of this application led to the review and improvement of existing 303(d) listing assessment methodologies, including an important advance in the development and implementation of biologically based cumulative frequency diagrams (CDFs), or “bioreference curves,” for defining allowable exceedances of WQS. The gradual decrease in “percent non-attainment” with incremental load reductions, observed for approximately 99% of the volume of the Chesapeake Bay and its tidal tributaries, supported identification of the total nutrient load allocation necessary to attain WQS.

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EVALUATING ECOSYSTEM SERVICES PROVIDED BY THE ALBEMARLE-PAMLICO (NC) ESTUARY SYSTEM IN RESPONSE TO WATERSHED NITROGEN MANAGEMENT

The Albemarle-Pamlico watershed and estuary study (APWES) is part of the USEPA Ecosystem Services Research Program. The mission of the APWES is to develop ecosystem services science to inform watershed and coastal management decisions in the Albemarle-Pamlico watershed and estuary. Due to the substantial body of regional scientific research, the watershed is an excellent area to examine the effects of multiple pressures on high value resources and services. Initially, research will seek to understand how reactive nitrogen (Nr) management influences seven ecosystem services (clean air; clean water; climate resilience; flood and storm protection; food; recreation; and biodiversity). Nr loading is expected to increase due to future growth in human population density and agricultural production. This study uses the DPSIR (Drivers-Pressures-State-Impact-Response) framework to address the consequences of nitrogen management decisions in the watershed. A systems-based approach will estimate the contributions of the many sources of nitrogen to the watershed and understand relationships between Nr loading, transformation, and transport from upland ecosystems to coastal estuaries. APWES research has three components: 1) Mapping and Monitoring, 2) Modeling, and 3) Decision Support Tool development. Mapping and monitoring projects will quantify ecosystem services, drivers and pressures to the system. Modeling projects will relate changes in drivers and pressures to changes in ecosystem services. Modeling research will include both empirical and mechanistic models for the airshed, watershed, and estuary. Decision support tools, including an interactive web-based software application and Bayesian networks, are being developed with the State of North Carolina, the Albemarle-Pamlico National Estuary Program and local stakeholder input to understand how watershed management decisions alter services within the estuary and to simulate scenarios of future changes.

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DEVELOPING INTEGRATED CONCEPTUAL ECOSYSTEM MODELS FOR USE BY HUMAN DIMENSIONS SCIENTISTS TO INFORM MANAGEMENT

The Marine and Estuarine Goal Setting for South Florida (MARES) program aims to reach a science-based consensus about the defining characteristics and fundamental regulating processes of a South Florida coastal marine ecosystem that is both sustainable and capable of providing the diverse ecological services upon which our society depends. MARES aims to achieve this goal through the development of: 1) integrated conceptual ecosystem models (ICEMs) that synthesize our knowledge about the natural system and human dimensions, and 2) indicators with target levels that will be utilized for indicator assessment. The ICEMs are developed through consensus-building meetings to produce both a modified DPSIR model where the Impact box has been replaced with Ecosystem services and an illustrated model to depict the spatial distribution of pressures, state, and human activities. ICEM sub-models are delineated by habitat type and incorporate “ecosystem attributes that people care about” as a means to integrate the social and natural sciences. These attributes are the product of the habitat sub-model that provides a means to identify ecosystem services and develop a thorough conceptualization of human benefits from the ecosystem. We will present the ICEM developed for the Florida Keys with a focus on the water column sub-model. This model covered will include defining the primary processes affecting the water column, identifying indicators of water column health and sustainability, and determining how the water column contributes to “ecosystem attributes that people care about.” This will be used to illustrate how MARES is synthesizing our knowledge about the ecosystem in a manner that is integrated with human dimensions. This talk complements another MARES talk entitled “Linking Human Dimensions and Ecosystem Values into Integrated Conceptual Ecosystem Models to Benefit Ecosystem Management” that focuses on the human dimensions of the water column sub-model.

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WATERSHED INFLUENCES ON NEARSHORE WATERS ACROSS THE ENTIRE U.S. GREAT LAKES COASTAL REGION

We have combined three elements of observation to enable a comprehensive characterization of the Great Lakes nearshore that links nearshore conditions with their adjacent coastal watersheds. The three elements are: 1) a shore-parallel, high-resolution survey of the nearshore using continuous sampling via towed in situ sensors for water quality and plankton; 2) a spatially-balanced, random probability survey of stations across the nearshore with measurements of water quality, plankton and benthos/sediments; and 3) characterization of all contributing coastal watersheds using metrics developed in a Great Lakes Environmental Indicators (GLEI) project. We recently completed ~6000 km of high-resolution nearshore tows (including most of the US coastline, conducted from 2004 to 2010). We piloted a random probability survey in the Lake Erie nearshore during 2009; subsequently, via the National Coastal Condition Assessment, the U.S. nearshore of all five lakes has been sampled (~400 stations in 2010). All sampling locations (continuous towing
and station points) have been geospatially associated with GLEI landscape metrics developed from an extensive GIS base for the U.S. basin. Using these data, we have developed powerful empirical models that relate nearshore variability to variability in landscape-level disturbance metrics spatially along the entire U.S. coast. This presentation uses the information to demonstrate scales at which we can observe how watersheds drive nearshore conditions. The models and spatial patterns indicate that non-point sources dominate where landscape-based nutrient loading is very high and contributing to undesired nearshore conditions. This abstract does not necessarily reflect U.S. EPA policy.

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**COMPARATIVE STUDY OF SALINE LAKE DYNAMICS AND RESTORATION RESPONSES IN THE EVERGLADES-FLORIDA BAY ECOTONE**

The ecotone between the Everglades and Florida Bay has been strongly impacted by historic water diversion from the Everglades watershed and is a focus of the Comprehensive Everglades Restoration Plan (CERP). The western portion of this ecotone (about 15 km long) is dominated by chains of lakes that have little inflow of freshwater from the Everglades (via Taylor Slough) and restricted exchange with Florida Bay. Before extensive Everglades drainage, these shallow lakes likely were oligohaline and dominated by submerged aquatic vegetation (SAV). Studied only over the past 15 years, they have commonly been hypersaline with high nutrient concentrations, phytoplankton blooms, and little SAV. The first phase of the C-111 Spreader Canal (C111SC) Project of CERP is intended to restore more natural patterns of freshwater flow (quantity, timing) through Taylor Slough, with the expectation that this will improve both the southeastern Everglades and Florida Bay, including at least part of the lake region along the western edge of Taylor Slough. However, these hydrologic changes also could (at least temporarily) increase nutrient export from the lakes to the bay and potentially stimulate bay phytoplankton blooms. To better understand the relationship between the Everglades watershed and Florida Bay and effects of CERP implementation, we are measuring water quality, nutrient export, system metabolism, and SAV in two chains of lakes that span the ecotone. We expect increased freshwater inflow, decreased salinity and residence time, and improved SAV habitat in the more easterly chain of lakes, proximate to Taylor Slough. However, we expect that this C111SC phase will have little influence on the more westerly chain of lakes. By contrasting the changing characteristics of these two sets of lakes, as well as downstream in Florida Bay, we will assess the influence of changing freshwater flow, including progress toward restoration targets and potential water quality tradeoffs.

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**LONG-TERM CHANGES IN SEDIMENT METABOLISM IN BOSTON HARBOR, MASSACHUSETTS**

Nutrient loadings to Boston Harbor, MA, have been dramatically reduced over the last 20 years through upgrades to sewage treatment and by the relocation of the sewage outfall to offshore in 2000. Estimates suggest that current nitrogen inputs to the harbor are now about 76% lower than N inputs in the early 1990’s. Organic matter inputs to the sediments have decreased by about 60% over the same time period due to the elimination of sludge and wastewater inputs to the harbor, and by a decrease in primary production. Sediment metabolism responded relatively rapidly to these changes in loading. Initially sediment oxygen demand and inorganic nutrients fluxes from the sediments increased at a number of sites as benthic animals colonized the organic rich muds. However, within a few years rates began to decrease and overall rates of sediment oxygen demand and dissolved inorganic nitrogen efflux fell by more than 50% at some sites. Rates of denitrification also decreased although decreases in denitrification were less than decreases in SOD. Because the decrease in denitrification was less than the decrease in loading, denitrification removes a substantially greater percentage of the N inputs to the Harbor now than when sewage was being discharged into the harbor. Although rates of benthic processes since outfall edification have remained lower than rates in the early 1990s there is substantial inter-annual variability. This variability appears to be driven in part by changes in the animal community and perhaps storms. Overall however, this study shows sediment metabolism responds fairly rapidly to changes in organic matter inputs and that organic rich sediments do not provide a long term legacy that will greatly slow whole ecosystems responses to restoration.

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**THE COMPLEXITY OF HABITAT COMPLEXITY: HOW PHYSICAL FEATURES OF A NEW ENGLAND ESTUARY SHAPE SEASONAL HABITAT USE OF MIGRATORY STRIPED BASS**

Acoustic telemetry is commonly used to study large-scale movements of aquatic species, but historically this tool has not been used to relate fine-scale seasonal movements to within-estuary physical habitat. Here, we seek to characterize the complexity of physical habitat within Plum Island Estuary (PIE), MA, and relate this complexity to the seasonal distribution of Atlantic coast striped bass (Morone saxatilis). Physical features that might attract feeding striped bass were identified (e.g. confluences, drop-offs, bottom unevenness, underwater structure, points of land). Using field measures and GIS, these physical features were quantified using multiple metrics. We created a complexity index, which combined habitat variables to test the additive effects of multiple physical features. In June 2009, 50 stripped bass (40-60cm TL) were tagged with acoustic tags. Striped bass distribution and habitat use were quantified monthly at 40 physically diverse locations (July-October) as well as at 7 continuously recording receivers. Thirty-five fish (70%) were detected in PIE for more than 30 days (mean = 50 days, range 2-113 days). These seasonal residents were not evenly distributed throughout the estuary (range 0-10 fish per acoustic range). Sites in the middle estuary had both the highest fish counts (8-10 individuals per location) and the highest complexity index values (i.e., some combination of high bottom rugosity, multiple confluences, large drop-offs, and proximity to points of land). Consequently, physical features that alter bathymetry, water movement, and prey distribution drive the heterogeneous distribution of striped bass. In summary, our study shows that it is not the presence of any single, isolated physical feature that attracts these fish, but rather the interactive effect of multiple, co-occurring physical features.

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**EUTROPHICATION AS A DRIVER OF ECOSYSTEM CHANGE IN THE COASTAL BAYS OF NEW JERSEY**

Barnegat Bay-Little Egg Harbor, a shallow coastal lagoon along the central New Jersey coastline, is in a state of insidious ecological decline due to ongoing nutrient loading and organic matter enrichment which have adversely affected the structure and function of the system. Nitrogen loading to this lagoonal estuary amounts to ~650,000 kg N yr⁻¹, and protracted water residence time in the estuary (~75 days during the summer) facilitates nitrogen uptake by plants and nitrogen accumulation in bottom sediments. As a result, biotic components of the estuary changed over time. Phytoplankton community composition has been dominated at times by raphidophytes and harmful algal blooms (brown tide, Aureococcus anophagefferens). Frequent macroalgal blooms have been documented along with the loss of critical seagrass (Zostera marina) habitat. In addition, shellfish resources (hard clams, Mercenaria mercenaria) have dramatically decreased over time. Symptoms of eutrophication over the past decade have also included low dissolved oxygen concentrations in the water column, epiphytic overgrowth on plants that attenuate light and limit photosynthesis, and algal mats overlying epipodiums of the estuarine floor. Key physico-chemical and biological indicators are being assessed to determine overall ecosystem condition, notably total nitrogen concentrations, chlorophyll a, dissolved oxygen, seiche depth, seagrass demographics (biomass, shoot density, blade length, and aerial cover), epiphytic overgrowth, macroalgae abundance and aerial cover, brown tide blooms, shellfish (hard clams and bay scallops) resources, and estuarine susceptibility.

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**BUILDING BRIDGES BETWEEN OCEAN SCIENTISTS AND THE COMMUNITY**

There is a glaring, gaping hole in the communication between scientists and the public. For many reasons, many scientists are not trained to communicate or collaborate with educators, even though making scientific research accessible to non-scientists is extremely important. Climate change, genetically modified organisms, and evolution are a few of the hot topics among the public that are rife with misconceptions. In addition, actively engaging and supporting underserved and underrepresented populations in K-12 marine science education is another necessary goal to narrow the gap. The primary role of the NSF funded network, Centers for Ocean Sciences Education Excellence (COSEE) is to create multi-faceted collaborations to integrate ongoing research in the ocean sciences with K-12 education and the public. In this talk, I will share what COSEE-West, one of 14 centers in the national network is doing to connect ocean scientists, educators, students, & the public. In addition, I will outline various ways COSEE-West assists scientists in developing and fulfilling their broader impacts statements for research proposals. Through multiple programs and
collaborative partners, COSEE-West has been effective in providing quality communication and we are always looking for new ideas, partners and approaches to enrich the interface between scientists, educators and the public.

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GULF COAST SALT MARSHES: DOES EUTROPHICATION = MORE GRAZING?

Salt marsh ecosystems have traditionally been considered to be bottom up regulated; however, recent research has suggested a top-down component in regulation of many salt marsh systems. Most research pertaining to top-down marsh regulation has been performed on the U.S. East Coast, in which Spartina alterniflora dominates. The major conclusions from these studies have indicated that top-down processes can substantially regulate the productivity in this system and can be exaggerated with fertilization. A marsh system in which few top-down regulation studies have been performed is a J. roemerianus dominated system. This study evaluates how grazing pressure varies with different levels of fertilization in J. roemerianus. Fertilizer was added bimonthly at low tides at a 16:1 N:P ratio to High (241.8 g N m⁻² y⁻¹) and Mid (120.9 g N m⁻² y⁻¹) fertilization treatments from April to August 2010, which was then sampled by sediment level vegetation clippings and compared to an adjacent non-fertilized control. The percentage of leaves grazed and the percentage of leaf length utilized for grazing was significantly higher in the fertilized treatments (p<0.001). Grazing intensity did significantly differ among treatments with the longest (p<0.001) and most severe scars (p<0.008) occurring in the High Fertilization treatment which led to higher leaf severance rates by August. Higher leaf severance rates led to a less aboveground biomass in the fertilized treatments. These findings suggest J. roemerianus grazers can and will preferentially graze on plants with higher nutrient content and increased grazing pressure can have negative impacts on the plant community.

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COMPARING BENTHIC REMINERALIZATION OF ORGANIC MATTER BETWEEN TWO FRINGING MANGROVE HABITATS WITHIN SOUTHERN ESTEROY BAY, FLORIDA

The dynamics of nutrient cycling in mangrove ecosystems vary greatly depending on region, tidal exchange, salinity and other factors. In this study, we determined the fluxes of dissolved organic carbon, nitrogen and phosphorus and dissolved inorganic nitrogen and phosphorus at the benthic boundary layer in two mangrove stands with different substrate, salinity and tidal flushing regimes in Estero Bay in southwest Florida. Benthic microcosm chamber experiments were conducted quarterly. Samples were collected every 45 minutes over the course of four hours with three time points in the light and three in the dark. Chamber nutrient fluxes were extrapolated to represent daily fluxes of organic matter between the sediment and water column. Preliminary results show that both sites were nitrogen-limited and act as sinks for dissolved organic nitrogen, dissolved phosphate and ammonium. Both sites were also sources of dissolved organic phosphorus into the water column. The well-flushed site also acts as a sink for dissolved organic carbon, while the fresher, poorly-flushed site acts as a source. For dissolved nitrate, the well-flushed site acted as a sink while the poorly-flushed site acted as a source.

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INTERACTIVE EFFECTS OF NUTRIENTS, SALINITY, AND FLOODING ON OLIGOHALINE WETLAND VEGETATION FOLLOWING SALTWATER INTRUSION

Storm-induced saltwater intrusion can lead to nectross and loss of aboveground vegetation in low-salinity wetlands due to salinity stress. Post-storm conditions such as nutrient status, degree of flooding, and salinity may impact the recovering vegetation and soil. The goal of our investigation was to determine the interactive effects of these conditions on the structure and function of oligohaline wetland vegetation following a saltwater intrusion event. In the greenhouse, wetland sods from a Sagittaria lancifolia-dominated marsh were subjected to elevated salinity (20 psu) for 6 weeks. The sods were then flushed with fresh water and a combination of nutrient (ambient [no addition] or elevated [20 g N m⁻² y⁻¹; 3 g P m⁻² y⁻¹]), flooding [flooded (12 cm) or drained (-12 cm)], and salinity (ambient [2 psu] or elevated [6 psu]) treatments were applied. Various plant growth and soil/interstitial variables were then assessed quarterly for 21 months. We found that flooding had a significant negative impact on plant diversity and cover, and had a positive impact on S. lancifolia density, dominance, and growth rate. Flooding was also associated with lower (more negative) soil redox intensity. Nutrient enrichment and ambient salinity enhanced S. lancifolia growth rate. Further, nutrient status, degree of flooding, and salinity significantly impacted density and diversity of other plant species. We conclude that post-storm conditions have the potential to significantly alter the structure and function of recovering wetlands, thereby altering the ecosystem services they provide.

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HOW DOES THE MONSOON INFLUENCE TOPOGRAPHIC CHARACTERISTICS, SOIL FACTORS, AND PLANT DISTRIBUTION ON A COASTAL DUNE IN THE NAKDONG RIVER ESTUARY?

Coastal dunes are positioned in between the landward edge of the backshore and the landward limit of Aeolian sand transport. This system is highly vulnerable against disturbances. In this study, we characterized changes of plant distribution, soil properties and geomorphology in coastal dune during monsoon season. We selected 600m x300m rectangular area in Dadaepo, the Nakdong River Estuary (35°05′N, 128°55′E) and subdivided it into 40 grids. Field survey was done in two periods (pre and post-monsoon). In each plot we surveyed soil, topological features and vegetation. Canonical correspondence analysis (CCA) was employed to identify the relations of species, soil and topographic variables during monsoon. The volumetric net change of study site was 33,104 m³. The overall proportion of variance explained by the first three CCA axis was 64.8%. First axis was mainly composed of a geomorphic gradient and water availability. ‘Distance’ (R²=0.94), elevation (R²=0.69), and soil water content (R²=0.60) were found to be a strong contributor. Second axis represented soil salt gradient. Soil electric conductivity (R²=0.35), and soil salinity (R²=0.33) were linked with the second CCA axis. When topographic and edaphic variables were compared, topological variables were dominant factors on dune vegetation zonation; however, their influence on vegetation change during monsoon was less prominent than edaphic variables. Carex pumilla, which covered the largest area before monsoon, decreased about 54%. This area was mainly replaced by Carex dactylon and inland exotic species (Oenothera odorata, Erigeron canadensis). Pragmites australis expanded its distribution and replaced adjacent community. Area of Suaeda japonica decreased more than 85%, and this area also replaced by P. australis. Understanding dune vegetation and environmental variables dynamics will be important basis for predicting the impacts of climate change, such as sea level rise and increased rainfall frequency.

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EXAMINING THE EFFECT OF SLOTTED WATER CONTROL STRUCTURES ON SALT MARSH NEKTON INGRESS AND EGRESS USING DUAL-FREQUENCY IDENTIFICATION SONAR (DIDSON) ACOUSTIC IMAGING

Water control structures (WCSs) installed to regulate water levels can alter both the hydrology and ecology of salt marshes. WCSs are thought to limit nekton ingress into, and egress from, managed marshes, but little research has directly examined how WCSs affect nekton behavior. Slots (vertical openings that span most of the water column) incorporated into WCSs are thought to facilitate nekton passage through structures, but little research has directly examined nekton passage through structures. Dual-frequencey identification sonar (DIDSON) acoustic imaging to examine nekton movement through two identical WCSs, each with three 15 cm-wide slots, located in tidal marsh channels and compare nekton behavior at WCSs and similar open (i.e., unmanaged) salt marsh creeks. Diurnal flood tides were examined monthly from April-September 2010 for a total of 18 hrs of sub-sampled acoustic imaging video recorded. Few individuals (24 migrating individuals per hour) were observed using the slots for passage through the WCSs. The size of migrants was similar at both WCSs (primarily 15-35 cm TL). Four times as many migrants were observed leaving the managed marsh than entering the managed marsh, but individuals observed during ingress and egress were the same size. Compared to similar open salt marsh creeks, greater nekton abundances were observed at WCSs during all months. No consistent patterns in nekton size were observed between the WCSs and open salt marsh creek. Acoustic imaging allowed a unique and comprehensive evaluation of nekton passage by permitting an examination of factors such as swimming direction and proportion of migrants that are unobservable with other sampling techniques.
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MACONDO I: WELL OIL-DERIVED POLYCYLCIC AROMATIC HYDROCARBONS ACCUMULATED IN MESOZOOPLANKTON FROM THE NORTHERN GULF OF MEXICO VIA TROPHIC TRANSFER

Mesozooplankton (> 200 μm) collected throughout August and September of 2010 from the northern Gulf of Mexico show evidence of exposure via trophic transfer to polycyclic aromatic hydrocarbons (PAHs) derived from oil released from the ruptured British Petroleum Macondo-1 (M-1) well associated with the R/V Deepwater Horizon blowout. Mesozooplankton tissue contained 0.03 – 97.9 ng g-1 of total PAHs. Alkylated PAHs were elevated relative to non-alkylated parent PAHs, indicating a petrogenic source. Multivariate statistical analysis revealed that distributions of PAHs extracted from mesozooplankton tissue were closely related to the PAH signature of the M-1 well. The distribution of PAHs isolated from mesozooplankton tissue extracted in this study shows that the spill event was the primary contributor to their contamination. The results suggest that bioaccumulation of PAHs likely occurred during the spill event.

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COMPLEX INTERACTIONS AND INTER-DECADAL CHANGES IN THE PELAGIC FOODWEB OF THE UPPER SAN FRANCISCO ESTUARY

Long-term declines in fish in the upper San Francisco Estuary may result in part from the low productivity of the foodweb in the low-salinity zone (LSZ) and the low abundance of copepods. An interdisciplinary study over the last four years has provided some insights into the functioning of this foodweb. Primary production was low, with much of it in cells <5 μm. Ciliates were consumed at high rates by both copepods and the clam Corbula amurensis. Copepods were chronically food limited, and consumed microzooplankton to a greater extent than phytoplankton. Egg production rates and growth were low for three copepod species, particularly in summer, and egg production rates of Pseudodiaptomus forbesi have been low for years. Consumption by clams was by far the dominant feature of this foodweb during summer. Clam grazing equalled or exceeded net growth rate of phytoplankton in late summer, and grazing by clams and microzooplankton together equalled or exceeded phytoplankton net growth rate throughout March-August 2006-2007. Consumption by clams also exceeded the population growth rates of ciliates. Egg production of the calanoid copepod Pseudodiaptomus forbesi was insufficient to offset estimated consumption of nauplii by clams. Egg production of Limnoithona tresacrina was also low, and persistence of these tiny cyclooids may reflect low predation on later life stages. Subsidies from other regions of the estuary are required to maintain populations: for example, P. forbesi in the LSZ is supplemented through transport from the freshwater region beyond the range of the brackish-water clams. The consumption of microzooplankton by copepods together with the high abundance of predatory copepods in late summer results in a long and therefore inefficient foodweb. Taken together, these results show a foodweb that is severely limited in its capacity to support pelagic fish.

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DO SEISMICALLY-IMAGED SAG STRUCTURES IN BISCAYNE NATIONAL PARK INFLUENCE SUBMARINE GROUNDWATER DISCHARGE?

A numerical model of variable density flow and constituent transport was used to investigate how 11 seismically-imaged sag structures recently defined by the USGS in Biscayne National Park might influence both submarine groundwater discharge (SGD) and marine chemistry. The model quantifies the proportion of SGD forced by (1) the terrestrial hydraulic gradient, (2) buoyancy associated with the mixing of ocean and terrestrial waters, and (3) Kolouh convection. Portions of SGD forced by other mechanisms, such as biosturbation or surface-gravity waves, are not described. The model was also used to investigate whether these structures influence the transport of heat and dissolved solids by SGD, and to partition SGD as a function of source aquifer-system. The model is based on a USGS hydrostratigraphic framework of the Florida peninsula. Maximum inner sag diameters range between 167 and 4886 m in the horizontal. The inner sag diameter is defined by a transition from concave to convex. The shallowedest identified structure is approximately 100 m below sea level, within the intermediate confining unit. The deepest structure is approximately 750 m below sea level, within the Eocene strata of the Florida aquifer system. Some structures may extend deeper, but interpretable reflection patterns do not exist within lowest parts of the profiles. The framework is represented in the model with 12 layers. The domain extends from the Everglades to submarine outcrops in the Atlantic Ocean. Model parameters are estimated by minimizing an objective function that describes the match between simulated and observed head. Sag structures are represented within the model by 116 conductance elements, which connect 11 of 12 model layers. Structure conductance is not currently well understood and requires further investigation. Conductance is represented in the model with a range of values.

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CARBON AND NITROGEN ACCUMULATION RATES IN SALT MARSHES IN OREGON, USA

Two important ecosystem services of wetlands are carbon sequestration and filtration of nutrients and particulates. We quantified the carbon and nitrogen accumulation rates in salt marshes at 135 plots distributed across eight estuaries located in Oregon, USA. Net carbon and nitrogen accumulation rates were quantified by measuring the carbon and nitrogen content of sediment that accumulated in marsh habitat over a two year time period using the fieldlapar marker horizon method. Short-term accretion rates were related to plot elevation, with low marsh habitats accreting at faster rates than high marsh habitats. On the average, the accretion rate appears to be balancing local sea level rise rate. High marsh habitat had higher carbon and nitrogen content and lower bulk densities than low marsh habitat. Low marsh habitat appeared to accumulate carbon and nitrogen at a higher rate than high marsh habitat. Data from this study will be used to generate a regional estimate of carbon and nitrogen accumulation in salt marsh habitat in estuaries in the Pacific Northwest region of the United States.

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δ13C and δ15N values in experimentally fertilized plots were higher than control plots. Changes in δ15N of salt marsh sediment with depth could be related to changes in estuarine nitrogen sources over time, and to changes in land use on the contributing watershed. To determine whether decadal-scale changes in nitrogen loading and sources are recorded in δ13C of salt marsh sediments, we collected and analyzed cores from salt marshes receiving different nitrogen loads and sources. Core samples were taken from experimental plots that were fertilized, and from salt marshes receiving different watershed-derived nitrogen loads. In salt marshes exposed to different watershed nitrogen inputs, sediment δ13C became heavier as nitrogen loads increased and wastewater sources became more dominant. δ15N values in experimentally fertilized plots were higher than control plots and increased over time, becoming heavier than the source fertilizer. The increase in sediment δ15N values in fertilized plots over the fertilizer δ15N value suggests that denitrification bacteria responded to the increased nitrogen load and fractionated available nitrogen. Denitrification could have lead to a loss of 33 - 75% of experimentally added N, a much larger proportion than the fraction buried in sediment.
COASTAL STORM SURGE MANAGEMENT UNDER CLIMATE CHANGE THROUGH INTEGRATION OF ADAPTATION PLANNING OF THE BUILT AND NATURAL ENVIRONMENTS

Coastal natural and built systems are so intertwined that cost-effective adaptation to higher storm surges under climate change will require joint planning of the two systems. Successful adaptation of the environment will result not only in healthy ecosystems necessary in themselves for sustainability, but also in the maintenance of ecosystem services (e.g., barrier beaches, mangrove forest and other coastal wetlands, and coral reefs for flood protection) that help to protect the built environment. Successful adaptation of the built environment will not only directly protect the built environment, but will also positively or negatively impact the health of ecosystems and their services. This is illustrated with case studies of Bonita Springs FL and Pt Arthur TX using the SLAMM and ADCIRC models to estimate impacts over time to the wetlands protecting each site and the adjacent developed areas behind them. Impacts due to scenario of storm surges of increasing height over time (and in the case of Bonita Springs inland freshwater flooding) were measured by areas flooded by land use type and the expected value of damages. Various integrated adaptation strategies were then developed consisting of actions to maintain the flood protection services of the wetlands and to protect the built environment by structural and flood proofing methods. The areas flooded by land use type and the expected value of the net benefits of each strategy were determined and the robustness as measured by how well each adaptation strategy performed over all the climate change scenarios determined.

INFLUENCE OF CLIMATE WARMING ON SOIL CARBON ACCUMULATION RATES IN SALT MARSHES

About half of all carbon burial in global oceans occurs in marshes, mangroves, and seagrasses. Moreover, where coastal wetlands are sediment deficient, ecosystem persistence depends on the balance between organic matter production and decay. We use a latitudinal gradient in Spartina alterniflora productivity to demonstrate that elevated temperatures will tend to increase salt marsh productivity by about 6% per degree of warming. However, we also report the results of a litterbag experiment where organic decay rates of Spartina alterniflora material increase by about 20% per degree of warming. Our results imply that decay rates are more sensitive than production rates, and that the net effect of warming could be to reduce soil carbon accumulation and make sediment deficient wetlands more vulnerable to sea level rise. Elevated temperatures tend to increase rates of sea level rise more than any acceleration in organic matter accumulation, suggesting the possibility of a positive feedback between climate, sea level rise, and carbon emissions in coastal environments.

A COMPARATIVE ASSESSMENT OF ECOSYSTEM SERVICES FOR GALVESTON BAY, TEXAS

Galveston Bay is economically the most valuable estuary in the State of Texas, conferring multiple beneficial forms of ecosystem services to the Greater Houston-Galveston region. Four categories of ecosystem services exist: 1) provisioning services (e.g., fishery harvest and freshwater supply), 2) regulating services (e.g., water quality improvement and flooding mitigation), 3) cultural services (e.g., recreational and educational opportunities), and 4) supporting services for other ecosystem services (e.g., soil formation and nutrient cycling). We conducted separate financial and energy analyses for selected ecosystem services under the four service categories using financial and biophysical valuation methods in a comparative way to contrast managerial implications for the estuarine ecosystem. Most of the financial benefits come from cultural services - recreational activities, due to its high leisure demands from the Houston metropolitan area. However, the energy analysis found that primary production is the most significant ecosystem service from the Bay. We hope that our comparative study will provide new insights in discussions of ecosystem service valuation, and provide an input to policy makers and stakeholders to broaden their appreciation of the complex interconnectivity between natural estuarine ecosystem services and the human economy, for improved management of estuaries, because the quantified values of financial and energy analyses reflect epistemological differences.

HYDROLOGICAL CONDITIONS CONTROL LOADING AND AQUATIC METABOLISM IN AN OLIGOTROPHIC, SUBTROPICAL ESTUARY

Everglades restoration calls for an increase in water delivery to the major watersheds of Everglades National Park. The responses of the estuarine end-members of these watersheds to hydrologic restoration are not entirely understood. In this project, we investigate how ecosystem metabolism in estuarine Taylor River, an important linkage between Taylor Slough and Florida Bay, is related to the existing hydrologic and water quality regime. We derived rates of aquatic metabolism from high-frequency (10-minute), free-water, diel changes in water column dissolved oxygen. Ecosystem gross primary production (GPP) and respiration (R) rates were greater in magnitude during low-flow, euhaline months than during high-flow, oligohaline months. Additionally, we found consistent net heterotropic conditions (GPP < R; NEP < 0) throughout the study duration. Salinity was often the best predictor of metabolism rates, highlighting the unique way in which freshwater delivery affects ecosystem function in Everglades estuaries. These findings demonstrate the sensitivity of oligotrophic estuaries to shifts in water delivery from the upstream watershed.

TEACHOCENTS.ORG - SOCIETIES PROMOTING A NETWORKING EFFORT AND RELATED RESOURCES FOR OCEAN SCIENCE K-16 EDUCATION

Starting in 2008 at an NSF sponsored workshop, representatives from ten professional societies have been working together to identify ways for scientific and educational professional societies to promote more effective outreach and education. The societies included those with an interest in K-12 education (The Oceanography Society, TOS), organizations with modest educational outreach at annual meetings (Marine Technology Society, MTS); Coastal and Estuarine Research Federation, CERF); American Geophysical Union, AGU); American Society of Limnology and Oceanography, ASLO); societies with
substantial programs focused in specific areas of K-12 education (American Meteorological Society, AEMS; Ecological Society of America, ESA); education-based societies with education and outreach as the primary focus (National Marine Educators Association, NMEA, National Science Teachers Association, NSTA) and one organization focused primarily on promoting diversity in science (Society for the Advancement of Chicanos and Native Americans in Science; SACNAS). At the first workshop, participants identified three primary focus points for future efforts: 1) identifying what means for the public and K-12 students to understand the science discipline of each society; 2) defining appropriate target audiences and how to engage membership and leadership; and 3) discussing mechanisms for bringing educators and scientists together through social networking. After numerous meetings a second workshop was convened in Washington DC in 2011 to formulate plans for the development of the Teach Ocean website (www.teachocean.org). Teach Ocean is being developed to serve as an electronic ‘yellow pages’ and networking forum to connect K-16 educators to society educational resources and programs at annual meetings. Educators will also be able to access distributed programming available through national and regional networks of society members with a commitment to education and outreach.

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IMPROVING OFFSHORE SEAGRASS MAPS OF FLORIDA’S SPRINGS COAST THROUGH A COMBINATION OF DIGITAL AERIAL IMAGERY AND REMOTE SENSING

Seagrass mapping of the near shore to middle offshore (mid-offshore) waters of Florida’s Springs Coast was completed in 2009 using high resolution (1 ft) DMC aerial imagery collected in April 2007. Although previous maps were completed of the near shore waters in 1999, the mid-offshore waters (beyond 6 miles) have mostly gone unmapped during recent times with only one broad scale seagrass map available from 1986. The new map of the mid-offshore area will be the first topic of this paper. This region comprised 860 of the 2000km² 2007 project area (near shore waters comprised 1140km²). The 2007 DMC aerial based map revealed an assemblage of seagrass beds much greater in complexity than mapped in 1986 and indicated that dense seagrass beds comprised a smaller area of the mid-offshore waters than originally estimated (64% instead of 83%). Whereas the 1986 map depicted a mostly monotypic stand of dense seagrass, the 2007 map delineated roughly 2700 polygons. This higher map detail will provide a solid baseline needed for completing change-detection analyses in the future. The second topic of this paper presents the results of a pilot study completed on the comparability of satellite imagery for mapping the mid-offshore beds. Since satellite imagery has become more affordable in recent years, an evaluation of its use was completed to provide information on potentially lower cost alternatives. A pilot area was independently mapped using low cost stock IKONOS imagery (4 m resolution) collected in May 2006. Although the 2007 DMC aerial imagery had better quality than the IKONOS imagery throughout most of the pilot area, both maps reported similar percentage summations of the three seagrass classifications (for IKONOS and DMC respectively: dense 62%,65%, sparse 28%,25%, patchy 4%,3%). The IKONOS based map achieved comparable summations of the three seagrass classifications (for IKONOS and DMC respectively: dense 62%,65%, sparse 28%,25%, patchy 4%,3%).

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A NEW SUBSIDENCE CURVE FOR MISSISSIPPI RIVER DELTA TIDE GAUGES AND ITS IMPLICATIONS FOR COASTAL RESTORATION

It is widely recognized that rates of relative sea level rise (RSLR) in Mississippi River Delta (MRD) are among the highest on Earth, and that this subsidence plays an important role in the massive wetland loss that has occurred along its coastline. However, there exists considerable disagreement over the magnitude of the rates of subsidence, and how they vary over time. Here we report a new method of tide gauge analysis, based on an understanding of the dynamical drivers of sea level change that removes most of the eustatic and interannual variability in the tide gauge record at Grand Isle, LA thereby providing a history of subsidence for this site. Results show that rates of subsidence at Grand Isle, LA fit a quasi-parabolic pattern, starting at 3.52 ± 2.79 mm/yr in the 1947-1952 period, reaching a maximum of 15.83 ± 3.06 mm/yr in the 1965-1970 period and then declining to 1.34 ± 0.60 mm/yr during 2001-2006. Temporal patterns in subsidence are closely coupled to temporal patterns of oil and gas withdrawal and rates of wetland loss in south Louisiana. These findings suggest that current rates of subsidence may be at the low end of many projections, suggesting that restoration of the large areas of the MRD is possible, particularly if large quantities of sediments can be trapped in the nearshore zone. Given these conditions, the greatest future threats to wetlands the MRD may come from climate change, and not subsidence.

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THE EFFECTS OF FRESHWATER DISCHARGE ON THE LOWER LAGUNA MADRE FOLLOWING LANDFALL OF HURRICANE ALEX, JULY 2010

Hurricane Alex struck northern Mexico on 1 July 2010 with substantial rain within the Rio Grande watershed. Direct precipitation, runoff, and flood control diversion channeled freshwater into the Lower Laguna Madre (LLM). From July to September 2010 we investigated the effects of the freshwater inflow from this event. Hydrographic (conductivity, temperature, dissolved oxygen-DO, pH, salinity, turbidity, and Secchi depth) and biological characteristics (water column chlorophyll a [Chl] concentrations and primary productivity) of the LLM were monitored over eight cruises. Salinity was highly variable, but displayed strong spatial trends. The freshwater inflow was sufficient to depress salinities to between 0 and 3 PSU by at least 6 August at 10 of our 13 sample stations for more than a month. Secchi depth ranged from about 1 m at sites nearer to the Brazos-Santiago Pass, but dropped to 0.3 to 0.6 m in areas with low salinity. Chl concentrations were between 1 and 5 μg L⁻¹ near the ocean, while concentrations of more than 20 μg L⁻¹ were found nearest low salinity sites. Net community primary productivity estimates were highly variable with mean rates greatest at the freshwater upstream site (0.063 mg O₂ μg⁻¹ Chlor⁻¹ hr⁻¹) and least at sites south of the freshwater intrusion (0.012 mg O₂ μg⁻¹ Chlor⁻¹ hr⁻¹), suggesting that bloom conditions and greater productivity were supported by inputs from freshwater supplementing the system. The greatest single impact from this freshwater disturbance may be the effect depressed salinities had on the seagrasses of the LLM. This event was of sufficient magnitude and duration to adversely affect seagrass distribution in the LLM. Much of the benthos of the LLM may enter into a new phase of secondary succession.

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THE ASSESSMENT OF SEDIMENT BED PROPERTIES WITHIN THE YORK RIVER ESTUARY AS A FUNCTION OF SPRING AND NEAP TIDAL CYCLES

Resuspension of fine-grained sediments is a critical factor affecting the physical, chemical, and biological health of estuarine environments. As a part of the National Science Foundation MUBED (Multi-disciplinary Benthic Exchange Dynamics) Project, a sedimentological study was conducted over a course of 5 weeks during the spring of 2010. The research was executed to assess the relationship between seabed properties and resulting bed erodibility in the York River Estuary, over spring and neap tidal cycles. Multiple GOMEX box cores were collected at Clay Bank, located 30 km upriver from the mouth of the estuary, and precautions were taken during core retrieval in order to preserve the sediment-water interface. Samples were then analyzed for erodibility using a Gust Microcosm, sub-sampled further for grain size, 78% presence, and water content, and were defined as physically or biologically influenced using s-radiography. Initial findings showed a considerable difference between water content of surficial sediments between spring and neap tide samples. Water content sub-sampled at 0-1 cm during neap tides averaged 81.8% (±1.08 standard deviation), whereas spring tide samples averaged 74.5% (±4.86 standard deviation). These findings build upon the results of companion MUBED studies, where it was suggested that increased erodibility is mainly due to recent ephemeral deposition associated with a transient local secondary turbidity maximum, whereas lower erodibility was associated with eroded or biologically reworked conditions.

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DO YOU LOOK LIKE A “TYPICAL” SCIENTIST? ANALYSIS OF MIDDLE AND HIGH SCHOOL STUDENT PERCEPTIONS OF SCIENCE AND SCIENTISTS

The Draw a Scientist Test (DAST), implemented for more than 50 years, investigates how K-12 students perceive science and scientists. As part of the Virginia Institute of Marine Science (VIMS) GK-12 “PERFECT” program, NSF GK-12 fellows implemented a modified version of the DAST survey in local classrooms. One of the primary goals of this ongoing project was to improve upon previous DAST rubrics and develop a novel approach for analyzing student perceptions. GK-12 fellows surveyed over 400 students in 5 schools (urban and suburban) ranging from 7th-12th grades. Each student imagined and drew what they perceived to be a “typical” scientist. Students were then asked to answer three questions to discuss: 1) identifying what it means to represent their drawings. Each image was analyzed using a modified DAST rubric to capture various aspects of each depiction, which include personal...
characteristics, symbols of research, gender, etc. Key modifications to the VIMS DAST rubric included the addition of experimental manipulation (lab vs. field) and highlighting key marine science characteristics (boat, scuba, etc.). Our results indicated that across the schools, there was a considerable increase in positive drawings after GK-12 “Scientist in Residence” exposure. All fellows noticed an increase in female or unidentified gender scientists after interaction, with female fellows noticing a substantial increase in the female/male ratio. Conversely, the male fellows saw no significant change in the female/male ratio. Other trends observed in the analysis include word choice description of a “typical” scientist, career choice depicted in the drawings, location of experiments, and other general characteristics of the images. Overall, the VIMS “PERFECT” GK-12 fellows found students’ perceptions of scientists had a positive increase both in the images drawn and word choice after being exposed to their “Scientist in Residence” after a year in the classroom.

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MONITORING CHANGES IN HIGH-TURBIDITY SUBMERGED AQUATIC VEGETATION (SAV) BEDS IN NORTH CAROLINA’S ESTUARIES USING SINGLE-BEAM SONAR AND LOW-LIGHT VIDEO

North Carolina has the second largest extent of submerged aquatic vegetation (SAV) in U.S. coastal waters but we are uncertain of its status; is it stable, is it declining, or is it increasing? Both intra-annual variability and turbid water conditions make it very difficult to reliably detect SAV with aerial or satellite based remote sensing tools alone. Here, we present data evaluating two boat-based detection methods using single-beam SONAR and low-light video cameras to classify SAV percent cover at four sites (2 low-salinity and 2-high-salinity) in order to estimate the sample sizes required for an inter-annual change analysis (power estimate). For SONAR, we used a BioSonics DT-X echosounder, single-beam 420-kHz transducer and the EcoSav algorithm. Time, date and geo-referenced video was collected along transects at 0.3-m intervals and classified by a trained observer for presence of SAV. The mean proportion of SAV-present classifications were computed along transects spaced at each site. Power analyses were used to compute the number of transects or records needed to detect a 10% change in percent cover between years. Both video and SONAR require a high sampling effort to detect a 10% change in the SAV percent cover. Kriging was computed on SONAR reports and compared for each month to show that SAV % cover changes more than 10% within a single year at all sites. The time of year for inter-annual surveys should be at peak periods of SAV cover, and detecting a change of >10% may be necessary. Cost estimates for various power levels and SAV change with each method are presented.

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KELP ALONG GREENLAND’S COAST - RESPONSE TO CLIMATE FORCING

We studied the depth extension, abundance and growth of kelp communities along Greenland’s coast spanning sub-arctic and arctic conditions from 64°N to 80°N, and covering a marked gradient in climatic conditions in terms of sea-ice cover and water temperature. Kelp belts formed subarctic forests along the entire climatic gradient and their depth range, abundance and growth increased from north towards south in parallel to increases in the length of the ice-free period which was about 2-3 months in the north and an entire year in the south. The maximum depth of 10% kelp cover increased from about 11 m in NW (78°N) to 27 m in SW (64°N) on average. Similarly, annual blade growth, estimated as the size of the new blade in late summer, increased from an average area of 0.4 m² and a biomass of 0.6 g dw in NW to an area of 1.3 m² and a biomass of 174 g dw in SW. The blades were generally least nutrient-rich furthest north and most nutrient-rich near glaciers probably due to nutrient inputs from land and reduced growth in these areas. These responses along the geographic climatic gradient suggest that Greenland’s kelp may respond to global warming by expanding their depth range, abundance and growth as the length of the ice free period increases, provided that the light energy gained by longer ice free periods is not counteracted by increased turbidity due to melting glaciers, that water temperatures do not exceed tipping points causing a negative carbon balance of the kelp during the long winters, and that nutrient supplies remain sufficient to support the increased growth. This prediction is supported by faster kelp growth in years with less sea ice in NE Greenland.

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DEVELOPING NEKTON-BASED METRICS OF HABITAT QUALITY FOR THE ASSESSMENT OF WETLAND RESTORATION IN TIDAL MANGROVE ECOSYSTEMS

Recent efforts to develop nektom-based metrics of restoration success have begun to move beyond measures of abundance towards those that are more biologically informative. To establish the variation in potential metrics of habitat quality for mangrove wetlands in Tampa Bay, Florida, we examined the nekton community from eleven small tidal tributaries classified as undeveloped, urban, industrial or mosquito ditch. Whereas mean density and species richness of total nekton were independent of land use, community structure differed between urban tributaries and those classified as non-urban (i.e., undeveloped, industrial, ditches). For example, in urban creeks, the community was skewed towards high densities of polychaete fish, but palaeonomid grass shrimp, typically dominant in estuaries, were nearly absent. Densities of economically valuable taxa in urban creeks were only half that observed in five of the six non-urban creeks. Furthermore, many common taxa were often found to be in relatively poor condition (3-22% smaller in mass), or were rarely collected, in urban creeks. However, biochemical condition of saillfin mollies (Poecilia latipinna), measured as storage lipids, was highest in urban creeks. Most reproductive traits for P. latipinna and grass shrimp were not consistently linked to land use. Apparently contrasts in the value of fish habitat among tributaries with divergent watershed and in-stream habitat attributes were reflected most prominently as: 1) differences in species-level densities and identity, 2) greater biochemical condition of P. latipinna in urban creeks and 3) fecundity of P. latipinna. Our results support the idea that abundance-based metrics calculated across pooled taxa often fail to discriminate among sites that differ in habitat quality. Future assessments of restoration success would benefit from the use of multiple metrics that capture change at the community level and reflect the energetic well being of populations at the species level.

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SPATIAL AND TEMPORAL VARIABILITY IN OYSTER FOOD QUANTITY AND QUALITY IN THE DELAWARE ESTUARY

Oysters are “ecosystem engineers” that can regulate water quality and plankton dynamics and furnish habitat for fish and other fauna. Factors that, in turn, affect oysters include recruitment, mortality, harvest pressure, disease, and food resources that fuel growth. Oysters, we know little about food limitation of oysters. Population production can be limited quantitatively or qualitatively because the demands of oysters vary with age and season, and the amount and type of seston in the water column also varies widely in time and space. Natural diets rarely match the animal’s demands. To examine how oyster food availability and quality varies in the Delaware Estuary, water samples were collected at eighteen stations over ten months during 2009, and repeated in 2010, to examine inter-annual differences. Seston was collected on filters from water samples, and replicates were examined for total particulate matter (PM, a.k.a. TSS), particulate organic matter (POM), organic content, and the proximate biochemical composition of protein, lipid and carbohydrate. Seston quantity and quality varied widely throughout the year and among locations, a pattern that was generally consistent between the two years. In general, seston quantity (PM and POM concentrations) was greater in spring and fall and also was more abundant in the upper estuary than in Delaware Bay. In contrast, seston organic content (% w/w) was inversely related to PM and POM concentrations, being greater downbay than upbay. Particulate protein, lipid and carbohydrate concentrations declined as the year progressed. Oyster condition (sampled in the fall) correlated best with the percentage content (% w/w) of protein and carbohydrate in the seston (during summer) and was inversely correlated with food quantity at all times of the year. These findings suggest that bottom-up limitation of oyster production is governed more by food quality than food quantity in the Delaware Estuary.
ASSESSING PHYTOPLANKTON COMMUNITIES IN TWO URBANIZED RIVERS WITH CONTRASTING INORGANIC NITROGEN SPECIATION

Regulatory policy for nutrient discharge in urbanization estuaries has resulted in large deviations from expected natural nutrient speciation (e.g. nitrate vs. ammonium or urea) and elemental (N:P) stoichiometry. One example of such impact can be found within the northern San Francisco Estuary system where two major wastewater treatment plants (WWTPs) have different effluent discharge requirements resulting in loading of ammonium to the Sacramento River and nitrate to the San Joaquin River. The resulting contrast in inorganic nitrogen loading to the two rivers feeding the estuary provides a natural experiment to test the hypothesis that shifts in phytoplankton community composition may occur as a result of the dominant inorganic nitrogen species present. Long-term monitoring of phytoplankton communities exists for the SFE based on conventional microscopy techniques. In recent years, these efforts have been augmented with new technologies (e.g. spectrofluorometry and flow cytometry) to indirectly monitor phytoplankton community structure. Over broader temporal and spatial scales, river transects in the Sacramento and San Joaquin Rivers were carried out in spring and summer 2010 and spring 2011 to characterize DIN concentrations and phytoplankton community structure upstream and downstream of the WWTPs. Phytoplankton community composition was assessed using four methods: conventional microscopy, size-fractionated chlorophyll-a concentrations, flow cytometry and spectrofluorometry (bbe FluoroProbe). From these observations we tested the hypothesis that diatoms will dominate in the nitrate-dominated system while cryptophytes and flagellates will dominate in waters with elevated ammonium. The impact of different contributions of nitrate vs. ammonium on phytoplankton speciation and the resultant pelagic food webs will be considered.

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FOOD WEB DYNAMICS IN MANGROVE ENVIRONMENTS: THE USE OF STABLE C AND N ISOTOPIES AS INDICATORS OF ENVIRONMENTAL CONDITIONS AND ANTHROPOGENIC INFLUENCE

The feasibility of mangrove leaves as a full diet for sesarmid crabs has been questioned. Leaves are generally N-poor and sesarmids must obtain N from other sources to sustain growth. This study assesses C and N allocation of sesarmid crabs under different environmental conditions using stable isotope (δ13C and δ15N). Possible food sources were: Leaves, benthic microalgae (BMA) and animal tissue (AT, e.g. fiddler crabs). The diet composition was assessed using the Isocron mixing model. Two Neotriposarma versicolor sites were chosen in the Bangrong mangrove forest (Phuket, Thailand). Site Rm had an open vegetation of Rhizophora mucronata and numerous fiddler crabs (i.e. Uca paradussumieri and U. forcipata), while site Ra had a dense vegetation of R. apiculata and was almost devoid of other fauna. Two mangrove forests, the sewage impacted Mtoni and the pristine Ras Dege, were selected near Dar es Salaam in Tanzania. Both Avicennia marina and R. mucronata vegetated forests were inhabited by Perisesarma guttatum and fiddler crabs (U. annulipes and U. urvillii). BMA and fiddler crabs were most abundant at Mtoni due to higher nutrient levels. The stable isotope mixing model indicates that C intake of N. versicolor in Thailand was dominated by leaves (~60%) at both sites. The rest was derived from BMA and AT. N intake, on the other hand, was dominated by AT at site Rm (~50%) and BMA at site Ra (~60%). δ15N of all organisms was higher in Mtoni compared to Ras Dege (up to ~9‰) in Tanzania. The mixing model shows that P guttatum in Ras Dege obtained 29 and 5% of its C and N from leaves, while 43 and 69%, respectively, came from AT. The situation was reversed in Mtoni where AT was negligible in the diet and BMA contributed with 44 and 76% of C and N. Thus, environmental conditions control the availability of food sources and dictate the diet of sesarmid crabs in mangrove forests. However, under pristine conditions they prefer AT as their dietary N source.

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PATTERNS IN NUTRIENT STANDING STOCKS AND MASS BALANCE IN NARRAGANSETT BAY, RI, WITH ONSET OF LOADING REDUCTIONS

Nutrient removal from wastewater effluent is becoming an increasingly popular management option as the cost of this technology comes down and awareness increases of the potential negative impacts of eutrophication on estuarine systems (e.g. hypoxia, fish kills, beach closures, etc.). However, while this management strategy has been implemented and studied in many estuaries throughout the world, our ability to predict the response of a system to a reduction in nutrient loading remains limited. Our research aims to quantify the response of a temperate estuary to reduced loading, and gain insight into how this, and other similar systems may respond to future loading decreases. We present results from a five year study in Narragansett Bay Rhode Island which took place concurrent with implementation of tertiary treatment at eleven major plants which discharge into the Bay. These upgrades reduced summer dissolved inorganic nitrogen (DIN) loading into the Bay by approximately 30%. We observe a statistically significant change in both the down-bay uptake rate of DIN and the total standing stock of DIN in the bay, but not the average concentration in the more eutrophied upper bay. We also do not observe a measurable coincident reduction in total nitrogen or a decrease in primary productivity, a possible indication that nutrient limitation is not occurring in the upper bay region. The nitrogen decrease, and resulting potential primary productivity decrease may occur with a time lag, but other components of the mass balance (e.g. benthic and/or water column recycling) may have shifted and the system budget may not change measurably. We also observe a significant reduction in phosphorus loading (both inorganic and total), although it is unlikely that this reduction is directly attributable to advanced wastewater treatment.

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SPATIAL AND TEMPORAL DYNAMICS OF CHLOROPHYLL IN THE LOWER SUIWANEE RIVER/ESTUARY: ANALYSIS OF A LONG-TERM DATASET

Differentiating natural variation in water quality from responses to increasing or decreasing anthropogenic inputs remains a key element of effective management. An important step in distinguishing these sources of variation involves characterizing dynamics within long-term datasets. This study modeled relationships between chlorophyll-a concentrations and salinity, temperature, light availability, and concentrations of total nitrogen and total phosphorus by applying time series and regression modeling techniques to monthly data from a system of concern: the Lower Suwannee River/Estuary. To increase the power to detect relationships, stations were grouped according to results of multivariate ordination, and models were developed using pooled data from 1999-2008. The predictive power of each model was evaluated using data from 1998, 2009, and 2010. As expected, final model parameters varied among groups of stations distributed in the river, reef, and offshore areas of the system; however, color and total phosphorus concentrations always explained significant amounts of variation in chlorophyll-a values. Chlorophyll-a concentrations exhibited different relationships to model covariates at the station level, although observations at the group level organized together. Models for groups of stations fit overall trends at all sites with adjusted R-squared values ranging from 0.40 to 0.72, but the accuracy of predictions differed among sites within each group. Potential explanations include fine-scale differences in top-down grazing pressure or bottom-up influences, such as reduced light availability due to color. These results demonstrate the value of routine sampling programs and highlight the need to consider multiple sources and scales of variation when attempting to distinguish natural variation from impairment or improvement.

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PHYTOPLANKTON COMMUNITIES IN LUSISIANA COASTAL WATERS AND THE CONTINENTAL SHELF

Louisiana coastal waters and the adjacent continental shelf receive large freshwater and nutrient inputs from the Mississippi and Atchafalya Rivers, creating favorable conditions for increased phytoplankton productivity. To examine inshore-offshore variation in phytoplankton community composition, we sampled inshore coastal waters near Vermilion, Terrebonne, and Barataria Bays during 2006 and the adjacent offshore continental shelf waters from 2002-2007. Phytoplankton abundance was greater in the coastal waters (range 5610-8230 cells L-1) and lower offshore (range 817-2190 cells L-1). Estimates of phytoplankton biovolume reflected the same pattern ranging from 0.15-38 x 106 μm3 inshore and 0.018-26 x 106 μm3 in offshore samples. Diatoms were the dominant taxon inshore and
offshore, comprising from 56-98% and 73-98% of total biovolume, respectively. Harmful algal species were present in both regimes, including the Protocentrum scutellum, Gymnodinium sanguineum, and Pseudonitzschia sp. Hydrographic and water quality data were collected including temperature, salinity, chlorophyll-a, total nitrogen (TN) and total phosphorus (TP). The similarities in community composition and the differences in biovolumes across the inshore to offshore gradient suggests nutrient loading and mixing as important processes regulating phytoplankton community dynamics in this region.

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NEKTON DENSITY PATTERNS AND HURRICANE RECOVERY IN SUBMERGED AQUATIC VEGETATION, AND ALONG NON-VEGETATED NATURAL AND CREATED EDGE HABITATS

Debate over the relative value of dominant shallow-water estuarine habitat types in support of nekton productivity remains a central issue affecting fisheries management and coastal management. Because of this, interhabitat comparisons are critically important in helping to define conservation priorities. We compared nekton habitat value of submerged aquatic vegetation, non-vegetated natural and man-made edge habitats in mesohaline interior marsh areas in southwest Louisiana using a 1-m2 throw trap and 3-mm bag seine. When present, SAV habitats supported close to 4 times greater densities and higher species richness of nekton as compared to either natural or man-made edge habitats, which supported similar densities to one another. Three species of concern (bayou killifish, diamond killifish, chain pipefish) were targeted in the analysis, and two of the three were collected almost entirely in SAV habitat. During the course of the study, Hurricanes Ike and Gustav passed directly over the study sites in September 2008. Subsequent analyses indicated significant reductions in resident nekton densities following these hurricanes, with no evidence of recovery 13 months post hurricane. Possible alteration of environmental characteristics such as scouring of SAV habitat, edge erosion and marsh loss, and extended high salinities may explain these lasting impacts.

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INTEGRATED ECOLOGICAL, ECONOMIC, AND QUALITY-OF-LIFE EVALUATIONS FOR LAND USE PLANNING DECISION SUPPORT: THE ECOSYSTEM PORTFOLIO MODEL

The U.S. Geological Survey (USGS) Ecosystem Portfolio Model (EPM) is an online multicriteria decision-support tool for land use and ecosystem restoration planning. There are currently three applications of the EPM: the South Florida EPM, the Puget Sound EPM, and the Santa Cruz Watershed EPM (Arizona/ Sonora). In the current versions of these applications, the EPM evaluates changes in ecological values (ecosystem services, valued ecosystem components, and other ecological criteria), economic criteria (economic value), and community quality-of-life criteria (natural hazard risks and vulnerability of human populations related to ecosystem services, housing affordability, and others) for scenarios of land-use management, water resources practices, and climate change impacts, mitigation and adaptation. Each individual application focuses on a subset of these criteria specific to the case study. The place-based approach allows us to create custom web interfaces that are easy to use (little GIS or specific model expertise required) for simultaneously creating and evaluating land-use scenarios and exploring ecosystem services and community quality-of-life. The multicriteria framework and use of scenario building promotes the integration of diverse expertise and inter disciplinary models, while recognizing the large uncertainties involved.

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DIFFERENTIAL HERBIVORE GRAZING IMPACTS ON ECOSYSTEM STRUCTURE WITHIN A EUTROPHIC, TROPICAL SEAGRASS BED

Herbivore grazing behaviors do not have an equivalent impact on ecosystem structure and these different influences are not detected unless appropriate parameters are measured. Differential impacts from turtle versus fish herbivory within a seagrass bed were evident in Thalassia testudinum rhizome carbohydrate storage and not in carbon, nitrogen or phosphorus tissue sampled. These differences remained significant six months after continued grazing by bayou killifish, and only limited recovery 13 months post hurricane. Significant differences occurred in seagrass species diversity and root carbohydrates with those patches abandoned having higher diversity and carbohydrates. These grazing patterns facilitate the maintenance of a seagrass ecosystem with overall higher diversity and productivity than would be found in a eutrophic environment without grazing, where a shift to an epiphytic-dominant seagrass bed is predicted. In this case, where high nutrient availability and patchy grazing allows beds to exist at different states (highly epiphytized or cropped without epiphytes) in the same landscape, continued productivity and increased overall ecosystem diversity is evident.

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DEVELOPING BENTHIC HABITAT MAPS AND INDICES OF HABITAT VALUE TO ASSIST IN SITTING OFFSHORE WIND FARMS WITHIN RHODE ISLAND WATERS

Recent interest in development of offshore wind farms within Rhode Island waters has initiated a need to map the distribution of benthic habitats and identify biological-environmental relationships. A thorough understanding of benthic habitats is essential to minimize construction impacts. Two challenges of mapping are appropriate methodology and effectively conveying information relevant to a range of users (scientists, managers, public). The methodology applied here can be extended to other areas, and work towards establishing a standard mapping protocol and facilitating more effective communications among users. To address the first challenge, the top-down and bottom-up mapping methods were compared for their ability to classify benthic habitats. The traditional top-down approach identifies biological assemblages based on geologic map units, as it assumes geologic environments contain distinct assemblages. Alternatively, the bottom-up approach aims to generate ecologically meaningful map units by establishing habitats based on biological similarity. Statistics are then used to determine relationships with abiotic parameters. This approach, however, is more resource-intensive. Both methods generated habitats with significantly distinct biological assemblages and revealed abiotic-biotic relationships. While the bottom-up approach yielded more clearly defined assemblages, spatial heterogeneity prevented development of full-coverage maps. Thus, at this time, the top-down method is recommended. The creation of indices of benthic habitat value to identify habitat “hot-spots” speaks to the second challenge. Habitats were classified according to abundance, diversity, value as a food source, presence of habitat-forming fauna, and habitat stability. While “hot spots” were identified, the indices, in general, did not indicate specific abiotic or biotic attributes that lead to high habitat value. Therefore, management efforts need to consider all habitat types.

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CONTRIBUTION OF INTERNAL AND EXTERNAL ORGANIC MATTER SOURCES AND SINKS TO THE FORMATION OF PERIODIC HYPOXIA IN A TRIBUTARY ESTUARY: THE YORK RIVER, VA

The seasonal formation of periodic hypoxia within tributary estuaries, and its relationship to the spring-neap tidal cycle, has been well documented in a number of systems along the U.S. east coast. However, the importance and scale of key physical and biological processes, which ultimately control the frequency and spatial extent of hypoxia is not well understood. We synthesized in-situ measurements, metabolic incubations, and high resolution water quality monitoring into a spatially-explicit, temporally-integrated mass balance to examine the significance of multiple organic matter sources and oxygen sinks in relationship to hypoxia in the York River estuary. The results from our study highlight both seasonal and episodic peaks in gross primary production (GPP) with phytoplankton production accounting for the bulk of total GPP within the system. Microphytobenthic production in both the macroalgae and polyhaline regions displayed seasonal shifts with an increase in production following the spring bloom; however their contribution to total GPP remained below 25% and typically accounted for less than 10% of total GPP throughout the spring, summer and fall. While GPP in some regions appears to be relatively balanced by internal respiration, our results indicate an area on the boundary of the mesohaline and polyhaline zones that represents a respiration basin within the river. Computed oxygen consumption was compared to unique open water measurements of respiration obtained from multiple Acrobat (Sea
and environmental agencies to improve water quality in the region. This multifaceted comparison indicated that internal respiration alone was capable of driving this system to hypoxia under stratified conditions, without the need for input of hypoxic water from the Chesapeake Bay. Nutrient reduction scenarios were conducted using a novel estuarine ecosystem model to simulate how potential management scenarios might affect GPP and hypoxia.

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ANALYZING THE TRENDS OF WATER QUALITY INDICATORS OVER TIME IN JAMAICA BAY, NY

Jamaica Bay is a eutrophic, shallow, coastal lagoon that receives 90% of its nitrogen from Waste Water Treatment Facilities (WWTF). Various organizations have collected water quality monitoring data in the Bay with varying spatial resolution and temporal frequency and duration. For this work, we integrated the various data sources into a single database so that we could identify long-term and short-term trends in variables (e.g. nitrate, orthophosphate, chlorophyll, dissolved oxygen) using different strategies for grouping sampling sites. We also examined relationships between drivers (e.g. weather conditions, nutrients) and response (e.g. chlorophyll and dissolved oxygen) variables. This work will help the Gateway National Recreation Area of the National Park Service by providing a template for integrating results from their ongoing water quality monitoring program.

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THE BAYOU BOEUF BASIN WATER QUALITY IMPROVEMENT PROJECT

The Bayou Boeuf Basin in south central Louisiana includes a network of bayous and canals in forested and flooded wetlands that drain surrounding agricultural fields as well as the northeastern part of the city of Thibodaux (pop. 15,000). 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, often bypassing wetlands to drain directly into open water bodies where water quality problems have been observed. 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 hydrological model is being developed to assist in determining the most efficient placement of hydrological modifications such as levee breaks along major drainage channels to allow water through the breaks into surrounding wetlands. This analysis aims to develop specific guidance for hydrological modifications to be implemented by local land stewards and environmental agencies to improve water quality in the region.


HINDCASTING HYDROLOGIC AND ECOCLOGICAL RESPONSE TO SEA LEVEL RISE IN THE COASTAL EVERGLADES TO MODEL FUTURE RESPONSE TO GLOBAL CHANGE AND RESTORATION

Our multidisciplinary team developed a framework to integrate historic data with models developed for the Comprehensive Everglades Restoration Plan in order to hindcast hydrologic and ecological response to SLR. With a reliable hindcast model of conditions under known SLR and hurricane disturbance, we can develop models for resource managers to project future conditions and response under various scenarios. Several components of the integration have been implemented. Modification of a USGS hydrodynamic numerical model (BISECT) to hindcast hydrological output for 1926-1932 successfully identified most flooding and hurricane storm surge events known for the period. We improved the initial model by developing appropriate modern-day surrogates for input data unavailable in the historic record. Variable hurricane windfields were derived from data available from NOAA’s Hurricane Research Division for modern hurricanes. Calibration of the model required reconciliation of hydrologic output to past shoreline changes and distributions of mangroves, marshes and tidal flats that we documented from historical charts and photographs. To interpret past changes, we improved a mechanistic model to define tipping points for vegetation change from hammock to mangrove via storm surge. A similar mangrove-marsh model is under development. We have completed the first trials to input regional downscaled data from global IPCC climate change models in order to project future scenarios. Hydrologic output from these models will be used in habitat suitability index and spatially explicit species models. We demonstrate the application to estuarine seagrasses and Florida manatee models under different Everglades restoration scenarios and rates of SLR. Model results do date support the efficacy of our approach and we continue to develop and refine the integration.

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N’P RATIOS AND TAXONOMIC SHIFTS AMONG MACROALGAL BLOOMS IN SOUTH FLORIDA’S COASTAL WATERS

The frequency and extent of macroalgal blooms have increased in South Florida’s coastal waters during the past two decades. Between 2004 and 2010, we monitored seawater nutrients and benthic macroalgae on reefs in Miami-Dade, Broward, Palm Beach and Martin counties in southeast Florida and Lee County in southwest Florida. In Dade and Broward counties, blooms were dominated by phaeophytes (Dichotomosiphon and cyanophytes (Lyngbya)) whereas off Palm Beach and Martin counties, blooms were dominated by chlorophytes (Codium, Caulerpa) and rhodophytes (Rhodophyta, Hypnea, and Agardhiella). These taxonomic shifts among South Florida counties correlated with changes in seawater TDP:TDP ratios, which decreased from Miami-Dade (60:1) > Broward > Palm Beach/Martin > Lee (20:1). These differences in N:P ratios resulted from both natural patterns in siliciclastic versus carbonate-rich geological substrata, as well as human activities on the watersheds. The spatial pattern in N:P ratios explains the taxonomic shifts in macroalgae among the counties studied. For example, phaeophyte blooms, which occurred under high N:P ratios, are characteristic of low N:P ratios, are characteristic of southwest Florida where toxic red tides also develop. These data illustrate the importance of nutrient availability as an ecological factor in the distribution of South Florida’s coral reefs, which are restricted to high N:P environments where macroalgae are strongly limited.

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DO CONDITION INDEX AND INCIDENCE OF DERMO DIFFER IN REEF FLAT VS. MANGROVE PROP ROOT OYSTERS?

In Rookery Bay, southwest Florida, the Eastern oyster (Crassostrea Virginica) is abundant both on reef flats and mangrove prop roots. We hypothesized that oyster condition and susceptibility to the parasite causing dermo vary with position in the intertidal zone, and between the more exposed reef flat and less exposed mangrove prop root environments. There is little research on the oysters living on mangrove prop roots, and none comparing oysters in this environment with those on the reef flat in the same area. On prop roots the oyster-mangrove matrix may be a unique system with oyster clumps growing vertically rather than horizontally. Also another key difference is the shading provide by the mangrove canopy, which may produce less stressful environmental conditions than those of oyster reef flats. For example, the shading from the canopy could be protecting oysters from heat and desiccation from solar exposure during summer low tide events. We will be focusing on basic observational studies of oyster vitality and disease status on reef flats and mangrove prop roots in Rookery Bay, and addressing the specific question: Do the intertidal position and location on mangrove versus reef flat affect shell morphology, condition index, and incidence of dermo? We are examining three sites in the Rookery Bay, with five reef patches (and paired oysters-mangrove associated) per site. Samples are being collected randomly at different patches and elevations on the reef flats and different heights on the mangrove prop roots. Sampling will be done quarterly with a total of 280 samples per sampling period, 60 samples from each site 30 samples from reef flats and 30 samples from mangrove prop roots. Oyster rectal tissue is being tested for dermo and the remainder of the oyster will be analyzed for condition index, and shell morphology.

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HYDRODYNAMICS AND RESIDENCE TIMES IN MEXICAN LAGOONS AND ESTUARIES

The oceanography of coastal lagoons and estuaries in Mexico will be reviewed in a comparative framework, which emphasizes differences in tides, freshwater inflow and topographic shape of the basin. Geographical regions will be recognized in terms of estuarine factors, and within those regions recognition will be given to how primary estuary types are expressed – salt–wedge estuaries, low–inflow estuaries, hypersaline estuaries, inverse estuaries, choked lagoons, and more. In spite of the diversity of systems, it is important to also see the similarities in systems that allow us to think of all of these as estuaries. In each system a mix of hydrodynamic processes interplay to control stratification, flushing and retention. Prior studies provide insight to processes in selected estuaries. Likely processes in other systems will be determined through comparative study, noting strong seasonal variability in some regions. Through estimating indices of residence time, this
insight on hydrodynamic process will be used to assess groups of estuaries and lagoons in the context of mass balance approaches for nutrients, phytoplankton, dissolved oxygen, and pollutants. In turn, this review of the comparative oceanography can provide useful information in assessing and managing human influences on the lagoons and estuaries of Mexico.

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DEVELOPMENT AND CHARACTERIZATION OF MICROSATELLITE MARKERS FOR THE SEAGRASS HALodule WRIGHTII

Halodule wrightii is a seagrass widely distributed in tropical areas, particularly in the western Atlantic. We have developed nine microsatellite markers from H. wrightii for use in genetic studies. The number of alleles ranged from 2 to 12 and the observed and expected heterozygosity ranged from 0.080 to 0.88, and from 0.077 to 0.86, respectively. No locus pair showed significant linkage disequilibrium after Bonferroni correction but several loci showed significant deviation from Hardy-Weinberg proportions in the tested population. These markers should prove useful for elucidating genetic structure, phylogenetic relationships, and ecological processes in this foundational coastal species.

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THE FUTURE OF GREAT LAKES RIVERMOUTH RESEARCH

The Great Lakes Rivermouth Collaboratory, a group of scientists and stakeholders representing academics, federal and state agencies, and non-governmental organizations (NGOs) are developing a conceptual model that draws upon existing data sources to synthesize the ‘state of the science’ for Great Lakes rivermouths. The rivermouth ecosystems are the freshwater analogs to estuaries, although the physical dynamics of these systems are controlled by river discharge and lake seiches (as opposed to tides). These systems encompass a mosaic of riverine, littoral, wetland, and coastal habitats; these are primary productivity and metabolic hotspots relative to pelagic waters and serve as important nursery and refuge habitat for Great Lakes fishes. Rivermouths are important hubs of human interaction with the Great Lakes because they are generally surrounded by dense population centers, they serve as the physical connection between the watershed and the Great Lakes, and they provide important ecosystem services. Collectively, however, these systems have received relatively little study. Intense focus has been restricted to a relatively small number of systems (e.g., St. Louis River, Muskegon River, and Old Woman Creek) or has been focused on a related class of coastal ecosystems (e.g., coastal wetlands). The Rivermouth Collaboratory represents a novel multi-agency and academic research partnership to achieve shared research, management, and restoration goals. For example, recent studies led by the U.S. Geological Survey and U.S. Environmental Protection Agency are focused on understanding the connections between rivermouth ecosystem disturbance, function, and ecosystem services. Watershed-based site selection is used as a shared sampling design to synthesize research project results and provides a means to study relevant system responses along a disturbance gradient.

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DEVELOPING OPTICAL WATER QUALITY MODELS USING GEOMETRIC MEAN FUNCTIONAL REGRESSION FOR THE INDIAN RIVER LAGOON SYSTEM, FLORIDA

Optical models have traditionally been computed using Model I least squares linear regression. However, least squares linear regression is inappropriate only when the causal (x) variables are measured with little error in comparison to the response (y) variable. We instead use Model II geometric mean functional regression (GMFR), as all our variables are subject to measurement error, it is orthogonal (minimizes errors in all directions), and it is invariant to scale changes. As such, GMFR models the functional relationship between all the variables, providing unique, unbiased solutions no matter what variable is used as the response variable (i.e., allows for full variable swapping). We used ambient water quality variables of optical relevancy to build a model that relates turbidity, Chlorophyll_a, and color (predictor variables) to the light extinction coefficient, or Kd (response variable). S-Plus code for GMFR from Draper and Smith (1988) was generalized to allow for three predictor variables, producing optical water quality models for sub-lagoons of the Indian River Lagoon (IRL) system. By simultaneously predicting causal variables from specific critical values of the response variable (Kd), we explore the application of these models to water quality target development in the IRL system.

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EUTROPHICATION IN THE GULF OF MAINE: ANALYSIS OF KEY EISP INDICATORS

The Gulf of Maine and its watershed encompass more than 170,000 km2 and is home to more than 6.5 million Canadians and Americans. Despite its long-standing importance to fisheries and natural resources and current interest in exploration of wind and tide as renewable energy sources, the ecosystem as a whole is not well understood. Acknowledging the need to evaluate the Gulf of Maine as a region-wide system, the Gulf of Maine Council on the Marine Environment (GOMC) launched an effort in 2004 to identify and deliver priority indicators of ecosystem health through the Ecosystem Indicator Partnership (EISP). Subcommittees were established for seven theme areas (coastal development, climate change, contaminants, eutrophication, aquatic habitats, fisheries and aquaculture). Currently more than 140 expert advisors from local, state/provincial and federal governments, along with academics and partners from non-government organizations participate in one or more of these subcommittees. Following a consensus-based process, the subcommittees selected priority indicators for each of the theme areas. One of the key theme areas for EISP is eutrophication resulting from point and non-point nutrient pollution. Data on four indicators were obtained to track trends in eutrophication (nitrogen loading, dissolved oxygen (DO), water clarity, and chlorophyll-a) for twenty-two embayments from Massachusetts through Nova Scotia. Results show that these important causal and response variables change spatially and temporally throughout the region. Moreover, associations between nitrogen inputs and DO, water clarity, and chlorophyll-a were observed. These results have implications for water quality management as well as for ecosystem health assessments. All of the data collected from the Gulf of Maine are currently available in EISP’s Indicator Reporting Tool (www2.gulfofmaine.org/eisp/reporting).

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THE EFFECTS OF ELEVATED SALINITY ON WETLAND SOIL ORGANIC CONTENT, VEGETATION STRUCTURE, AND PHYSIOLOGY OF TAXODIUM DISTICHUM WITHIN THE LOWER ST. JOHNS RIVER

Sea levels are predicted to rise approximately 2.5 mm/yr due to global warming. As a result, freshwater coastal wetlands will experience increased salt water intrusion. The elevated salinity is expected to cause significant changes to freshwater wetland soil chemistry and vegetation structure. Three wetland sites were chosen along a salinity gradient within the lower St. John’s River. The sites were defined as freshwater, oligohaline, and polyhaline vegetation structure. Three wetland sites were chosen along a salinity gradient within the lower St. John’s River. The sites were defined as freshwater, oligohaline, and polyhaline vegetation structure. The dominant vegetation species include Salal palmetto, Nyssa sylvatica, Taxodium distichum, Nyssa aquatica, Magnolia virginiana, Myrica cerifera and Acrostichum daniellii. The vegetation within the oligohaline site was composed of stressed or remnant Fraxinus caroliniana and Taxodium distichum. The understory was composed of Typha, Cephalanthus occidentalis, and Umbelliferae spathacea. Groundcover was a monoculture of Panicum repens. The vegetation at the polyhaline site was predominantly Spartina alterniflora with intermittent Juncus.
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ECOSYSTEM SERVICES, GIS, AND SIMPLIFIED NATURAL RESOURCE DAMAGE ASSESSMENT

Natural Resource Damage Assessment (NRDA) uses several methods to compare the ecosystem services lost from a spill or release with those gained through restoration projects. Often damages from small incidents are not pursued because the cost of prosecution is greater than the expected payoff. The Fish and Wildlife Service is leading development of new, simplified techniques for valuing the loss of ecosystem services from small oil spills and contaminants releases. Several studies have used pre-existing geographic information system (GIS) layers of ecosystem information and value estimates from a variety of studies to measure the value of natural resources. While this reasoning is economically incorrect, applying similar logic to measure the marginal change in the value of ecosystem services due to a contaminant incident is defensible. This paper shows the theoretical connection from changes in ecosystem services to damage values and how GIS can be applied to simplify NRDA damage estimates. This work applies ideas that have been developing at the intersection of ecosystem services assessment and economic valuation to solve a practical problem and provide added resources for restoration.

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EROSIONAL SORTING AND RESUSPENSION DYNAMICS OF SAND-MUD MIXTURES

The size-sorting of fine sediment during erosion is a key determinant of where mucks can accumulate. Investigation of size-sorting in a variety of environments such as estuaries, tidal flats, and on the continental shelf over various spatial and temporal scales can help elucidate the re-suspension and transport dynamics and subsequent fate of fine bottom sediment. Bottom cores with an undisturbed sediment-water interface were collected at several locations over a six year period. The cores were exposed to increasing shear stresses using a Gurtt microcosm erosion device. In addition to determining erosion rates, samples of the suspensate were filtered during the erosion experiments and were analyzed for disaggregated inorganic grain size using a Coulter Counter Multisizer. Size-specific relative mobility plots were generated to determine the degree of sorting of bottom sediment. Results from all different locales show that non-cohesive, sandy sediments can sort under increasing bottom shear stress with increasingly coarser grains being suspended as stress increases. In cohesive, muddy sediments, all size classes are eroded at equal rates. The factor that determines sorting behavior appears to be linked to the <4um fraction. When this fraction rises above 5-10%, sorting of material finer than 16um does not occur. Effectively, a muddy-sand when resuspended can winnow or clean-out its fine grain fraction, while the size distribution of a sandy-mud or mud remains intact and is transported en masse. Sorting dynamics will change in response to accumulation or removal of finer grained material. The differences in sorting over various spatial and temporal scales can lead to the trapping of unconsolidated muds.

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APPLICATION OF MULTIBEAM ECHOSOUNCERS IN CHESAPEAKE BAY OYSTER RESTORATION

The NOAA Chesapeake Bay Office (NOAA) uses a multibeam echosounder as a tool to chart the distribution of surficial materials and describe the surface complexity of oyster habitat to inform native oyster restoration activities. Tied corrected multibeam bathymetry provides accurate surface data for site selection, design, and implementation of reef construction projects that must meet federal permitting requirements for depth. Post reef construction and shell planting surveys provide a baseline for monitoring the change in areal extent and habitat surface complexity from construction methods using both artificial substrates and shell planting; and any changes in reef morphology that may accrue over time from oyster growth, reproduction, mortality, or harvest. In addition, the backscatter amplitudes of each sounding are used to determine the actual planting bounds of spat on shell providing precise boundaries for future monitoring of restored reefs. Using U.S. Army Corps of Engineers reef construction projects on the Severn River, Harris Creek and Choptank River, we investigated optimal resolutions for determining surface complexity metrics and demonstrated the value of multibeam sonar mapping for oyster restoration and monitoring. We discuss the best practices for conducting accurate and repeatable multibeam surveys for high resolution horizontal and vertical positioning.

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PHYSICAL EFFECTS OF REEF RUGOSITY ON THREE DIMENSIONAL HYDRODYNAMICS AND SEDIMENTATION OVER TRANSPLANTED OYSTER REEFS IN A SHALLOW TIDAL CREEK SYSTEM

The purpose of this study is to identify and quantify the physical effects that reef rugosity has on both three dimensional flow dynamics and sedimentation over constructed oyster reefs in a shallow tidal creek system. Benthic bivalves are keystone species and play a crucial role in nutrient cycling within their ecosystem, both increasing productivity and improving water quality. In recent years, the viability of using transplanted oyster reefs to mitigate anthropogenic effects on water quality has been investigated. For this study, oyster reefs will be constructed in a shallow tidal creek system in New Hanover County, North Carolina, USA, and will be altered with respect to rugosity, a measure of reef surface roughness. Three-dimensional hydrodynamics over the reefs will be measured using Aquadopp® 3-D current profilers (by Nortek), and sediment data will be collected by using sediment traps placed along the reefs’ surface. Hydrodynamic flow data and sedimentation rates will be compared with respect to reef rugosity.

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DOES ECOPTYPIC-BASED GENETIC DIVERSITY OF A DOMINANT PLANT IMPACT ECOSYSTEM HEALTH AND STABILITY? A CASE STUDY IN A RESTORED SPARTINA ALTERNIFLORA MARSH

Increased genetic diversity of habitat-forming species correlates with increased faunal diversity and enhances ecosystem resiliency to and recovery from disturbances. Genetic diversity at the species level may be just as important as species diversity for the long term health and stability of ecosystems. To identify the benefits of increased genetic diversity within a single plant species, I performed a common garden experiment in a constructed salt marsh in Galveston Bay, Texas. The nutrient acquisition patterns and productivity of genetically distinct Spartina alterniflora populations (ecotypes) in monoculture plots (single population) were compared to polyculture plots (two or three populations). Early trends suggest that polyculture treatments have more live plant material and increased shoot production a month after transplanting. I also examined interactions between increased genetic diversity of S. alterniflora and its colonizing insect and spider communities. At this early development stage of the restored marsh, few of these arthropods have colonized the site. Plant genetic diversity may strengthen over time as the plant community develops. In an effort to maintain diverse community assemblages and ecosystem stability, increased genetic diversity of a dominant primary producer may be an important consideration.

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ANAEROBIC METABOLISM IN CHESAPEAKE BAY

Seasonal oxygen depletion is a common feature of coastal and estuarine systems. It results in a temporal and spatial succession of microbial respiratory processes as higher energy yield terminal electron acceptors are depleted. Here we report temporal and spatial studies of respiration variability from May to October in the mesohaline Chesapeake Bay. Measurements on both aerobic and anaerobic respiration using changes of dissolved inorganic carbon (TICO2) and oxygen reveal that the respiratory quotient (RQ) varied in time and space. The excess of net TCO2 production over oxygen consumption resulted in high RQs, indicating that the anaerobic metabolism was higher than aerobic metabolism. Conversely, chemoheterotrophic bacteria, taking up TCO2, for growth along with oxygen, exceeded heterotrophic TCO2 respiration and resulted in the net consumption of TCO2 as reduced NH3 and H2S were oxidized. These anaerobic microbial processes, usually observed in marine sediments, were observed in the water column during seasonal hypoxia. Accordingly, the TCO2 and oxygen respiration were comparable within the aerobic zone, while these first anaerobic measurements in the water column show the temporal and spatial variability of anaerobic microbial metabolism.
BRINGING UNDERGRADUATE STUDENTS INTO SEDIMENT DYNAMICS FIELD CLASS

Sediment dynamics is a difficult course for undergraduate students. To cope with students' barrier in comprehending difficult basic concepts, hands-on experience on field experiment and data analysis was combined to lectures. In spring of 2011, a field experiment was conducted on a macrotidal beach with a stone fishing weir on the west coast of Korea. The rectangular-shaped 1-m-high stone weir is 100-m wide and 80-m deep with an opening to the landward on the intertidal beach. The intertidal region outside the stone weir is composed mainly of sands, while much finer sediments are found inside the stone weir. Students designed and conducted a field experiment to examine the sedimentological difference between inside and outside the stone weir at the beginning of the class. During subsequent weeks of the semester, students were given lectures and related data analysis, leading to the understanding of the accumulation of finer sediment inside the stone weir.

TIDAL CURRENT CHARACTERISTICS WITH THE DIURNAL TIDAL SYSTEM IN A SHALLOW ESTUARY

Mobile Bay, which is located in the northern Gulf of Mexico, is a relatively broad (~17 km) and shallow (~3 m) estuary, and it has a narrow ship channel of 13~15 m deep and 220 m wide. Mobile bay connects to the Gulf of Mexico with two inlets: Main Pass, which is the dominant term in the water exchange, and Pass au Herons. Tides are predominantly diurnal and small with range of 0 to 40 cm, and this estuary tends to be highly stratified because of the large freshwater inflow. A towed ADCP survey was conducted at the Main Pass during the beginning of the flood and end of the ebb covering a half tidal cycle. Results of the harmonic analysis show that tidal flows are about 4.8 hours (72°) ahead of the water level at the most of the shallow area of the Main Pass, and about 20 minutes (3.37°) current phase lags exist between shallow areas and the ship channel. Surface flows lag behind bottom flows at the ship channel (bottom flows change their direction first) due to the combined effects of friction and inertia. Opposite direction of flows to the flow at the ship channel develops at the right side of the ship channel, looking into the estuary. Strong velocity shear develops at the right side of the ship channel, and it creates a strong negative vortex during the flood at that region.

IMPACTS OF FOUNDATION SPECIES RICHNESS ON ECOSYSTEM STRUCTURE AND FUNCTION

Numerous studies explore the impacts of decreased biodiversity on ecosystem structure and function. Loss of foundation species, such as seagrasses and corals can indirectly have a disproportionate effect on ecosystem structure and processes due to the provision of refuge. In many environments, the presence of foundation species can increase the abundance and diversity of associated fauna. A mesocosm experiment will be conducted using mimics of 3 common structure-forming coral species: Diplora sp., Acropora palmata and Acropora cervicornis. The 4 habitat treatments are monocolonies of each coral species and a polyculture of all three; raggity will remain consistent across all treatments since available hiding spaces can influence habitat selection. All treatments will be presented in paired choice tests to a reef-dwelling vertebrate herbivore. The preferred habitat will be determined by taking digital video recordings during experiments. It is predicted that organisms will prefer a more speciose habitat. Predation is known to be an important community-structuring process. Three vertebrate reef-dwelling herbivores will be placed in each of the 4 mesocosm tanks containing the habitat treatments. A free-swimming predator will be added to each tank and predation rates will be used to determine if foundation species richness impacts herbivore survivorship. Predation rates and habitat preference can influence organism resource use and energy transfer throughout the food web. In light of recent large scale biodiversity losses, it becomes increasingly important to understand the effects of biodiversity loss on ecosystem structure and function.

EVALUATING THE VARIABILITY OF SEDIMENT AND NUTRIENT LOADING INTO TEXAS ESTUARIES AND BAYS FROM RIVERINE SYSTEMS

Since 2009, the U.S. Geological Survey (USGS), in cooperation with the Texas Water Development Board (TWDB), have been evaluating the variability of sediment and nutrient loads in the lower reaches of the Trinity River during a variety of hydrologic conditions. Discharge, sediment concentration, and nutrient concentration data are collected to gain a better understanding of the hydrologic and water-quality characteristics for the Galveston Bay coastal ecosystem. This ongoing study is designed to help characterize the sediment and nutrient load transported into Galveston Bay as related to localized periods of high flow and releases of water from reservoirs upstream in the watershed. As an extension of the data collection that began in 2009 on the Trinity River, the collection of similar sediment and nutrient data by the USGS in cooperation with the TWDB in the lower reaches of the Colorado River and San Jacinto River in Texas began in 2010. In addition to collecting nutrient and suspend-sediment samples to improve our understanding of the amounts of sediment and nutrients entering into the Matagorda Bay and Galveston Bay estuary respectively, periodic bedload samples are collected from the lower Colorado River and San Jacinto River sites to quantify the contribution of bedload sediment to total sediment discharges. The initial sediment and nutrient loading estimates from this study indicate that discrete and continuous water quality data can be used to make load estimates for sediment and nutrients. With a better understanding of the loads of these constituents, it might be possible to better understand the role sediment and nutrient loads have on the ecological health of other Texas Gulf estuaries and bays.

MANGROVE ECOSYSTEM FUNCTION AND RESPONSE TO CHANGE: A BIOGEOGRAPHIC PERSPECTIVE

Mangroves provide key ecosystem functions and services to protected tropical coasts in terms of production and storage of organic carbon, provision of a structurally complex habitat for animals as well as mitigating environmental disturbances ranging from localised pollution to tsunamis. Despite their established ecosystem values, mangroves remain globally threatened through clearance and general habitat degradation especially in tropical developing countries, while significant (but often simplistic) planting efforts are implemented concurrently. The volume of mangrove research has, similar to other fields of coastal and estuarine research, grown exponentially in the last few decades. While these efforts have successfully documented basic mangrove ecosystem structure and function, mangroves still present a unique challenge to understanding the relationship between biodiversity and ecosystem function and the resilience of mangroves to environmental change. Mangroves ecosystems are unique as plant species richness and diversity are low both at global, regional and local scales. Significant differences in species richness also occur between biogeographic regions. The influence of such patterns in species richness and diversity on ecosystem function and support for essential ecosystem services is poorly known. How mangrove ecosystems of different biodiversity in different biogeographic regions might respond to environmental change at global, regional and local scales is also unclear. This special session draws upon the general expertise of and specific studies conducted by researchers from various mangrove biogeographic regions to shed light and synthesise on these issues.

DO MANGROVE ECOSYSTEMS WITH DIFFERENT LEVELS OF DIVERSITY FUNCTION DIFFERENTLY?

Generic ecosystem services, e.g. carbon source and nursery habitat for estuarine consumers, are often attributed to mangroves without reference to forest characteristics such as species diversity. Local plant species richness of forest patches (scale of hundreds of metres) is often low irrespective of bioregions, probably maintained by a combination of propagule supply, disturbance regime and physiological tolerances. At the global scale, however, species richness and mangroves in the Indo-west-Pacific (IWP) is significantly higher than the Atlantic-east-Pacifc (AEP). Preliminary comparisons suggest there may be differences in aspects of ecosystem function between the two bioregions, in addition to positive correlations between faunal and plant species richness. A global comparison of data on productivity, carbon mineralisation rate and other major biogeochemical processes is performed on the two bioregions, with special reference to the potential influence of local and regional species richness on ecosystem function. A conceptual model on how this linkage may occur is proposed.

THE ROLE OF REGIONAL CLIMATE AND OTHER FACTORS IN CONTROLLING HYPOXIA

We have examined the processes controlling summer hypoxia in the mainstream portion of the Chesapeake Bay. The analysis is based on the Chesapeake Bay Monitoring Program data collected from 1985 to 2007. Self-organizing map analysis indicates that bottom water dissolved oxygen starts to be depleted in the upper mesohaline areas in late spring, and hypoxic conditions expand down-estuary by early summer. Hypoxia appears to be related to multiple variables, including river discharge, nutrient load, stratification, algal biomass, and wind conditions. The Susquehanna River contributes both nutrient loads from the land and buoyancy effects on estuarine dynamics. The concentration of spring chlorophyll-a, a proxy for spring algal biomass, is also associated with the initiation and duration of hypoxia.
Spring cross-bay wind is significantly correlated with summer hypoxia, which is influenced by regional climate. The empirical orthogonal function (EOF) analysis of sea level pressure anomalies reveals that the second EOF mode is significantly correlated with spring wind between February and April. We have hypothesized that spring wind possibly affects the deposition or transport of spring bloom biomass in the bay, which may alleviate or increase summer hypoxia. Using two numerical simulation models, the Regional Ocean Modeling System (ROMS) and the Larval Transport Lagrangian model (LTRANS), residual flow fields and particle movements are compared between 2000 and 2003, two hydrologically similar years. Results indicate that more particles are transported into the shallow western and lower bay during 2000 than 2003, consistent with less hypoxic condition in 2000 than 2003.

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PATCHINESS IN PHYTOPLANKTON COMMUNITY COMPOSITION AND WATER QUALITY IN SAN FRANCISCO ESTUARY

Quantifying food resources at the base of the food web is both important and difficult in estuaries where food is limited and the geographical area is large and structurally complex. This research was conducted to determine if food resources associated with phytoplankton community composition are patchy and associated with high frequency change in environmental conditions in San Francisco Estuary. Phytoplankton patchiness was determined from high frequency measurements of phytoplankton species composition using digital imaging flow cytometry along longitudinal transects in the Sacramento and San Joaquin Rivers between April and October 2010. Continuous water temperature, pH, specific conductance, dissolved oxygen concentration, chlorophyll fluorescence and turbidity were measured using YSI water quality sondes. The phytoplankton community was primarily composed of diatoms, cryptophytes and cyanobacteria which comprised 92-96% of the biomass. Phytoplankton biomass among taxa was patchy along river transects where 14% of the biomass peaks were greater or equal to 1 standard deviation unit from the mean and only 5% of the peaks were greater than 2 standard deviation units from the mean. Water quality conditions were also variable with 18-33% of the measurements equal or greater than 1 standard deviation unit from the mean and only 3-4% of the values greater than 2 standard deviation units from the mean. Percent phytoplankton biomass and water quality conditions were significantly correlated with most of the phytoplankton community associated with specific conductance and water temperature in the Sacramento River and turbidity in the San Joaquin River. Periodic and non-periodic patterns in the percent phytoplankton biomass among taxa over time and space suggested high frequency spatial and temporal measurements are needed to gain an accurate estimate of phytoplankton food resources at the base of the food web.

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CUMULATIVE RISKS TO EASTERN OYSTERS, CRASSOSTREA VIRGINICA IN THE JAMES RIVER, VA

In an effort to apply Cumulative Risk Assessment (CRA) as developed by the U.S. EPA, the present study investigates the cumulative risks to Eastern oysters due to multiple stressors such as salinity, temperature and oxygen and carbon dioxide. I also compared the effectiveness of the Hazard Quotient Method (HQ) in CRA. Ambient conditions in the James River, VA were obtained from the Virginia DEQ database and respiratory responses were estimated using values from the literature. The multiple environmental stresses are evaluated using a probabilistic analysis that combines the environmental conditions. It was concluded that salinity was the most influential stressor in the model. Other risks were identified contributing to the vulnerability of the oysters. Crystal Ball simulations yielded that the oxygen uptake of oysters reduced by more than 29%. The HQ method was found to be inappropriate in analyzing cumulative risks for CRA. Oyster populations are dramatically declining in the James River and the Chesapeake Bay. Hence, effective oyster restoration activities are underway to rebuild oyster populations in the James River and throughout the Bay area.

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COMMUNICATING ESTUARY CURRENTS AND MODELING THROUGH AN INTERACTIVE COMPUTER EXHIBIT

We are developing an inquiry based exhibit to educate the public about the variability of currents in an estuary and how scientific models can be used to study estuary dynamics. Physical oceanography and modeling have recently become priorities in national and state-level goals for science and math curriculum as well as ocean literacy, but neither goal has been prioritized for specific content or educational materials has been created. The exhibit theme introduced to these topics is Olympia Oyster restoration in the local Yaquina Bay Estuary. The interactive game component mimics a method for native oyster restoration efforts, depositing oyster shells, removed during harvesting, back into the estuary to create habitat for oyster larvae to settle onto. The user is tasked with helping these efforts by finding a location in the estuary where a) the currents are not too strong that oyster larvae get washed into the ocean, and b) there is enough circulation to deliver food and support oyster growth. The site for prototyping and evaluation of the exhibit is the Hatfield Marine Science Center (HMSC) in Newport, Oregon. Research on the effectiveness of the exhibit will inform future strategies for communicating physical oceanography research topics and scientific modeling methods to general audiences.

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USE OF TIDE STAKES TO INTERPRET FLOW PATHWAYS AND ELEVATION PATTERNS IN A DITCHED NEW ENGLAND SALT MARSH

Many New England salt marshes have been ditched since colonial times to help control mosquito populations and increase salt marsh hay production by improving water drainage. While these ditches are prominent geomorphic features, little quantitative work has focused on how these ditches may alter marsh hydrology and geomorphology. This study attempts to quantify the ways in which ditches alter sediment and water transport pathways, in turn affecting the overall morphology and surface geology. To quantify and compare flow patterns in ditched and non-ditched marsh areas, water height was measured relative to stakes over the course of a tidal cycle allowing for a better determination of areas that flooded first and the duration of water on the marsh surface. Relative elevation was measured with a simple technique using water-soluble glue painted onto bamboo stakes, and was found to be accurate within 2 cm. As the marsh was flooded, the maximum water height was recorded on the stakes as the rising tide dissolved the glue up to the height of high tide. A GIS analysis was used to quantify the lengths of ditches in the creek systems. In addition, short-term sedimentation rates, suspended solids, organic matter, and grain size were measured. The marsh flooding patterns were highly dependent on the proximity to ditches and a pattern of decreasing elevation with increasing ditch length was present. Marsh platform elevation measurements indicated that the interior regions of ditched areas stand significantly lower than non-ditched areas. The hydrologic data demonstrated that the interior regions of ditched marsh areas were typically flooded first and stayed flooded longer, while non-ditched interior marshes were flooded last and stayed flooded for a shorter period of time. In response to modified flow pathways, classic patterns of sedimentation and of organic matter and grain size distribution occurred less often in ditched marsh areas relative to non-ditched areas.

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THE INFLUENCE OF DRAINAGE NETWORK AND MORPHOLOGICAL FEATURES ON THE VEGETATION RECOVERY PATTERN OF A MACRO-TIDAL WETLAND RESTORATION PROJECT

This research examines the role that surface morphology and drainage networks have on the natural recovery of marsh vegetation within a macro-tidal restoration site. Previous works examining salt marsh vegetation recovery have shown that success is most successful when: (1) there is no restriction on the dispersal ability of target species nearby the restoration site, and (2), there is a disturbance to remove non-target species within the restoration area. The St. Croix River salt marsh restoration site is a self designed restoration project located on an agricultural dykeland that was actively breached in the fall of 2009. This site is located within the macro-tidal portion of the Bay of Fundy. Rod Surface-Elevation Table (RSET) measured an increase in the sediment surface of up 23 cm in first year of restoration. The high rate of sediment deposition resulted in the creation mudflats over much of the area. To better understand factors influencing vegetation recovery and surface changes an unmanned-helium-filled-blimp-and-suspended-camera system was deployed to capture low
altitude aerial photographs. Prior to blimp deployment a series of geo-referenced ground control points were installed to facilitate orthorectification of the image mosaic. Preliminary hydrogeomorphic analysis shows the reactivation of old agricultural ditches into the drainage network. Vegetation surveys using 1m2 quadrats show the colonization of marsh species, such as Polygonum hydropiper and Scirpus validus, resulting in a change of vegetation dominance from pasture grasses to marsh species within the first year of restoration. Preliminary description of the orthophotos showed that bare patches exceed vegetated patches during the first growing season. Preliminary image analysis shows that colonization of target species has primarily occurred near secondary drainage channels. These results suggest colonization occurred following the return of tidal waters and sediment deposition.

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OFF THE SHELF, ONTO THE SHORE: PUTTING SCIENCE TO WORK SOLVING TODAY’S PROBLEMS IN COASTAL MANAGEMENT

Today’s natural resource management challenges indicate that current decision-making structures are inadequate to address long-term trends in social-ecological challenges such as habitat loss, non-point source pollution, and climate change. As management trends continue toward an ecosystem-based approach, it is critical to integrate expert knowledge systems from fields such as science and engineering with the place-based interests and values of communities, resulting in management decisions that promote shared interests. Solutions depend on high-quality science, but often the most effective solutions require utilizing multiple types of knowledge and expertise. Early engagement in problem definition and ongoing stakeholder participation in adaptive management is key to identifying and addressing potential barriers to application of research results. This calls for greater collaboration between scientists, managers, and other stakeholders in an iterative process that incorporates both ecosystem and policy sciences. The University of New Hampshire’s Master’s program Training for the Integration of Decision-making and Ecosystem Science (TIDES) is designed to provide the theory and skills necessary to connect the knowledge achieved through high-quality research with the decision-making needs of communities that depend on ecosystem services. This session is designed to not only share information but also demonstrate the pedagogy of the collaborative process and its value in coastal management. We will share four examples of collaboration in this initial presentation then engage the audience in a decision-making exercise at the close of the session to explore a collaborative process.

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COASTAL OCEAN OBSERVING IN THE CAROLINAS

The Carolinas Regional Coastal Ocean Observing System (RCOOS), 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 2007 through funding provided by NOAA IOOS, the Carolinas RCOOS includes a network of offshore buoys that continuously collect meteorological and oceanographic data and report this information hourly through the RCOOS web portal (www.CarolinasRCOOS.org) and the SECOORA and National Data Buoy Center (NDBC) websites. The near real-time information supplements traditional sampling efforts undertaken prior to 2007 in the Carolinas by legacy systems. Partnerships with the National Estuarine Research Reserves in North and South Carolina, NDBC, U.S. Marine Base Camp LeJeune, the Coastal Data Information Program, and the U.S. Army Corps of Engineers have allowed the Carolinas RCOOS to expand its observing and data management activities to include water quality and climate parameters, surface wave measurements, and a variety of stakeholder driven products. This presentation will focus on these and other examples of partnership activities which have improved the quality and timeliness of coastal observations and the delivery of this information to end-users for use as a management tool.

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FIELD OBSERVATIONS AND MODELLING OF HOLOCENE SEA-LEVEL CHANGES IN THE SOUTHERN BAY OF BISCAY: KEYS TO UNDERSTAND CURRENT RELATIVE SEA-LEVEL RATES ALONG THE ATLANTIC COAST OF SW EUROPE

The absence of basal peat in the stratigraphic sequences of the southern Bay of Biscay has long precluded the development of Holocene sea-level curves. We have approached this problem by combining the indicative depositional meaning (derived from the micropaleontological composition and sand content) with radiocarbon ages of 55 borehole samples obtained from three estuarine areas of the southern Bay of Biscay. These new sea-level index points have produced the first complete Holocene sea-level curve from this area. We further reviewed all available sea-level data from SW Europe to provide the regional trend and use these data to calibrate a recently developed isostatic model. Field data and model reconstructions present a good agreement for the region considered. A north-south trend can be observed, where isostatic rebound seems to be minimized in the south of the Iberian Peninsula while local factors tend to dominate during the late Holocene. These newly produced sea-level curves have contributed to improve isostatic model predictions and provided pre-anthropogenic sea-level rise rates against which modern rates can be compared. The research was funded by the following projects: TANYA (MICINN, CGL2009-08840), 801T365-10 (Harea-Coastal Geology Research Group), K-Egokitzen II (Climate Change: Impact and Adaptation, Etoretko 2010), Acção Integrada Luso-Espanhola number E-2080/ Acción Integrada Hispano-Portuguesa HP2007-0098. It represents a Contribution to Geo-Q Research Unit (Josuán Gómez de Llarena Laboratory).

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USING LAGRANGIAN PARTICLE TRACKING IN ESTUARINE MODELS TO QUANTIFY RESIDENCE TIME AND MIXING IN ESTUARIES

Lagrangian methods in estuarine physics research are important because they link the dependence of water mass transport pathways (and materials contained in water parcels), important to estuarine ecology and water quality, to the underlying dynamics that drives the time dependent circulation in estuaries. Here we use Lagrangian particle tracking methods in numerical simulations of three estuaries with distinct forcing regimes (the Merrimack River, the Hudson River and Yaquina Bay) to quantify residence time and spatial and temporal patterns of turbulent salt fluxes. Mean residence time is a bulk measure of the typical time a water parcel spends in an estuary. Using particle tracking, mean residence time and its distribution, along with their dependences on forcing are quantified. Residence times calculated by this method are compared to residence times based on salt flux estimates (e.g., as estimated from the Total Exchange Flow, TEF, formulation). Transport pathways of water parcels originating from the ocean are also studied and locations where significant water mass transformations occur, through turbulent salt fluxes, are quantified.

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GREATER SUCCESS IN RESTORATION RESEARCH WITH UNDERGRADUATES

Utilizing undergraduates in publishable scientific research can lead to more rewarding experiences than many may expect. This opportunity for inquiry-based learning allows you to complete work on projects that may not be able to be done as successfully with graduate students or research associates. Additionally, high quality upperclassmen are often as qualified and motivated as first year graduate students. Important steps to implementing research successfully with undergraduates will be discussed (from identifying project needs and learning objectives to training and overseeing undergraduate interns and volunteers). As well, a specific large scale field restoration project with extensive field and lab components that was made significantly more successful in outcomes as well as grant matching because of the use of undergraduate students will be described.

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SOUTH SAN FRANCISCO BAY FLOOD RISK AND UNCERTAINTY ANALYSIS

A methodology was developed and applied for the estimation of flood risk for the South San Francisco Bay shoreline that included explicit analysis of uncertainty and risk required for the economic analysis of the project. The methodology used detailed deterministic process numerical models for long wave tidal surge propagation within the system, locally generated wind waves, wave runup and overtopping of levees and levee erosion as well as tributary flooding that overtops riverine levees. The effects of the variability in the boundary conditions for all of the processes were handled in a cascading effect Monte Carlo model that utilized the boundary condition probabilities with a probabilistic treatment of failure of protective levees in series and parallel configurations. Care was used to insure that correlations between the boundary conditions were accounted for in this Monte Carlo simulations. Levee breaching was incorporated into the Monte Carlo analysis by performing...
a series of long-wave model simulations with and without breaching of the levees. The appropriate breach condition was then selected within the Monte Carlo simulations based on the estimated probability of each levee failure for the variable forcing conditions during the life cycles of events in repetitive Monte Carlo simulations. Statistical analysis of repetitions of the Monte Carlo model simulations provided detailed estimates of the uncertainty of the flood levels within the study area. The analysis was applied to future conditions, addressing the uncertainty of sea level rise in the boundary conditions of the Monte Carlo model as well as the deterministic process models.

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ESTABLISHING NUMERIC NUTRIENT CRITERIA IN SARASOTA BAY, FLORIDA

Sarasota Bay is recognized as an estuary of national significance. As has been the case in many coastal areas in Florida, the Sarasota Bay area has undergone significant population growth since the 1950s. Increases in nutrient loads associated with increased population and development have been well documented in the scientific literature. Because of the increase in nutrient loads and the desire to restore and maintain healthy, productive ecosystems, management actions have been initiated by the SBEP to address the effects of increased nutrient loads. The U.S. Environmental Protection Agency (USEPA) is currently developing numeric nutrient water quality standards for Florida’s estuaries and coastal waters, the goal of which is to protect the designated uses of water bodies as prescribed by the Clean Water Act. The Sarasota Bay Estuary Program (SBEP) has been making recommendations for nutrient criteria for its estuarine waters using a paradigm that is similar to that used by the neighboring Tampa Bay Estuary Program and the USEPA. The paradigm calls for the establishment of targets for response variables (seagrass, chlorophyll a) and the development of defensible relationships which can be used to develop nutrient criteria that are consistent with these targets. The SBEP area is divided into five bay segments and segment-specific seagrass and chlorophyll a targets have been established. The chlorophyll a target was defined as the annual mean of the period that was deemed to be protective of seagrass and water clarity. Because of natural variability, a distinction is made between a target, i.e., a desired concentration, and a threshold, i.e., a level above which chlorophyll concentrations are undesirable. Stressor-response relationships were developed between chlorophyll a and TN concentrations using linear regression. These relationships were then used to identify the appropriate nutrient criteria that are associated with the adopted chlorophyll a thresholds.

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ESTUARINE APPLIED ECOLOGY AND RESTORATION: A TEAM-BASED COLLABORATIVE RESEARCH COURSE

Undergraduate research is usually more exciting in groups and we have developed a team-based collaborative research course to investigate aspects of environmental restoration in estuarine environments. A class of 15 is divided into three teams with related objectives, and the teams work together in field work, laboratory analyses and frequent group presentations of research progress. For example, we have followed a restoration of a Hudson River estuarine cove severely polluted with metals and studied the loss of resistance of a genetically distinct species, the export of metals, and effects on the benthic community. Another course followed the potential for oyster restoration in an urban bay, considering nutrient limitation of phytoplankton, oyster function, and water quality. In both types of study, the work depended upon the presence of a research laboratory and field facilities, such as an Audubon field station on the Hudson. In all cases the small team size encouraged strong interactions and the objective of producing collaborative research was achieved.

When one team was overwhelmed it was possible to induct the services of members of other teams, which greatly helped to knit the class together. On the other hand, students were When one team was overwhelmed it was possible to induct the services of members of other teams, which greatly helped to knit the class together. On the other hand, students were

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CLIMATE CHANGE, PRECIPITATION AND IMPACTS ON ESTUARINE RESTORATION

A tradeoff between growth rate and disease prevalence as a function of salinity makes the estuarine salinity transition of special concern for oyster survival and restoration. Estuarine salinity varies with discharge, so increases or decreases in precipitation with climate change may shift regions of low salinity and disease refuge away from optimal oyster bottom habitat, negatively impacting reproduction and survival. We examined growth, reproduction, and survival of oysters in the New York Harbor-Hudson River region, focusing on a low-salinity refuge in the estuary. Observations were during two years when rainfall was above average and comparable to projected future increases in precipitation in the region and a past period of about 15 years with high precipitation. We found a clear tradeoff between oyster growth and vulnerability to disease. Oysters survived well when exposed to intermediate salinities during two summers (2008, 2010) with moderate discharge conditions. However, increased precipitation and discharge in 2009 reduced salinities in the region with suitable benthic habitat, greatly increasing oyster mortality. To evaluate the estuarine conditions over longer periods, we applied a numerical model of the Hudson to simulate salinities over the past century. Model results suggest that much of the region with suitable benthic habitat that historically had been a low salinity refuge region may be vulnerable to higher mortality and failure for restoration under projected increases of precipitation and discharge. Management of estuaries requires spatial modeling of precipitation-discharge in relation to salinity structure for future management of estuarine restoration. In the case of the Hudson, a crucial refuge that optimizes oyster growth with lack of disease and predators can readily be lost with decadal changes in precipitation or under future models of climate change.

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EFFECTS OF EPIFAUNAL GRAZER SPECIES ON EELGRASS (ZOSTERA MARINA) IN SAN FRANCISCO BAY

Studies in various parts of the world have found that epifaunal grazer species can vary from one another in their effects on seagrass growth. However, the impacts of the suite of grazer species found in San Francisco Bay eelgrass (Zostera marina) beds have not yet been compared. We investigated the effects of five common eelgrass epifauna species, Idotea rесеstа (native isopod), Phyllaphysаs tаilоr (а native opisthobranch), Amphitоhе vаlidа (аn introduced gаmmаrdi аmphid), lillymаssа sоbоletа (аn introduced prоsobrаch), аnd Cарреllа c. dреnасhоr (аn introduced cарреllid аmphid). We set up a series of flow-through mesocosms, each containing three shoots of eelgrass and one of the aforementioned species at densities that resulted in approximately equal grazer biomass. Eelgrass shoots were trimmed to a uniform starting length and some tanks were left without animals as controls. After fifteen days, one eelgrass shoot was removed from each tank, scraped of epiphytes, and length and dry weight were measured. Significant differences among the different grazer treatments were observed in the length and dry weight of eelgrass shoots and in the mass of epiphytic algae, indicating that these species do vary in their effects on eelgrass. Negative effects through direct consumption of eelgrass were pronounced for the invasive amphid Amphitоhе vаlidа and positive effects were pronounced for the native isопоd Iдоtеа rесеstа. These data are being used to guide further study of invertebrate assemblage effects and factors influencing the distribution and effects of grazers, with implications for restoration of eelgrass habitats in San Francisco Bay.

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ASSESSING THE POTENTIAL EFFECTIVENESS OF A CATCH-AND-RELEASE-ONLY RESERVE ALONG FLORIDA’S EAST COAST FOR REBUILDING COMMON SNOOK (CENTROPOMUS UNDECIMALIS) POPULATIONS

Florida has adopted strong measures to rebuild overfished populations of common snook (Centropomus undecimalis), a predacious hermaphroditic and important apex predator in the state’s estuaries. However, no-take marine protected areas (MPAs) have not yet been used as a management tool. We developed a dynamic population model to compare fishery and population effects for 84 alternative combinations of regulatory measures, with and without an MPA. All options assumed that catch and release (C&R) angling would continue, even within the MPA. Snook were harvested in fully fished systems only. A sub-population of snook was protected from harvest in the conceptualized MPA, a coastal sector encompassing a freshwater tributary, estuarine basin and oceanic inlet. After 30 model years, large fish (females) were 2-76% more abundant for alternatives with an MPA than for fully fished alternatives; differences were greater at higher fishing rates. Rebuilding benefits were
similar if a scenario either: (a) incorporated an MPA, or (b) reduced fishing to lowest levels tested, demonstrating a trade-off between these approaches. Surprisingly, independent of MPA effects, the population had more large fish if size limits (harvest slot) were set to target smaller size classes (males). Measures that would intensify already restrictive catch limits may not be politically practical or socio-economically beneficial. A balanced strategy with a network of MPAs embedded among neighboring fully-fished systems appears to be advantageous. Such a strategy may also buffer the broader population against environmental perturbations, including climate change. Although we could not quantify spillover or recruitment, populations in neighboring fully fished systems may benefit from a subsidy due to the build-up of large fecund females in the MPA. Rebuilding common snook populations may have a greater chance of success if MPAs became part of the overall management strategy.

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ASYMPTOMATIC TIDAL STRAINING AND MECHANISM INVESTIGATION

Tidal straining is a phenomenon of temporal variations in stratification and mixing resulting from the interaction of a longitudinal salinity gradient with the vertical shear of the horizontal tidal velocity. As a result, the theory predicts stronger and weaker stratification during ebb/low tide and flood/high tide, respectively. In contrast to this well-known temporal asymmetry, in this study, we document in situ measurements demonstrating a lateral asymmetry and lateral inversion of tidal straining at Barataria Pass, Louisiana. During flood, the eastern side of the channel had strong stratification of 4 PSU salinity change over a 1.5 m thin layer while the western side had a 2 PSU change over a 12 m water column. This strong lateral difference decreased as flood continued until near the end of the flood when it reached vertically well-mixed condition across the channel. During ebb the western side became stratified while the eastern end was well-mixed. This resulted in a small correlation coefficient of 0.05 for stratification between the west and east sides, although the central channel and east side have a high correlation coefficient of 0.88. The tidally averaged salinity was higher on the western side, except in a narrow boundary layer close to the eastern shore. This is an apparent contradiction to what the Coriolis effect should produce. A numerical model simulation shows that the observed difference arises from the influence of the river water coming out of the Mississippi River through the Southwest Pass of the Birdfoot Delta. The relatively fresh coastal current enters into the inlet, mostly from the eastern end. The interaction with tidal oscillation produced the asymmetric tidal straining observed.

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ARE ORGANIC MARINE AGGREGATES “HOTSPOTS” FOR VIRUSES?

Marine viruses are well-known mediators of carbon and nutrient cycling in the water column. However, with respect to their biogeochemical roles when associated with suspended marine aggregates (marine snow), there has been more speculation than study. Aggregates are small-scale patches of higher microbial biomass and productivity compared to the surrounding seawater. Their concentrations in coastal surface waters can range as high as 100-1000 aggregates per liter. We are testing the hypothesis that like bacteria, the abundance of viruses is enriched on marine aggregates relative to adjacent, aggregate-free water. We generate aggregates in laboratory microcosms, and using epifluorescence microscopy, enumerate virus-like particles (VLPs) associated with the aggregates and those in water samples. Most of our efforts to date have been methodological, i.e., effectively separating the VLPs from aggregates so they can be quantified. We will discuss our methods and present data testing our hypothesis. If the abundance of VLPs is indeed elevated on aggregates, then speculation about viral influences on biogeochemical processes is well-justified.

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MICROPHOTOBENTHOS MODELING IN SHALLOW ESTUARIES: IMPORTANCE FOR NUTRIENT DYNAMICS AND MASS BALANCE

Nutrient dynamics in shallow sub-estuaries of Chesapeake Bay are dramatically altered by the presence of microphytobenthos, in turn controlled by light and sediment grain size. Using laboratory-derived nutrient flux from sediments collected from the field, algorithms for nutrient dynamics were incorporated into a hydrodynamic - biogeochemical model (UNTRIM and CE-QUAL-ICM) for the Lynnhaven estuary. Following inclusion of light penetration into surficial sediments in the model, the presence of coarse-grain associated benthic microalgae resulted in nutrient uptake and lowered ambient concentrations and higher DO levels from photosynthesis. In contrast, finer sediments without the benthic microalgae had little nutrient uptake resulting in little change and even nutrient increases from sediment flux. Using spatial distributions of the sediments in the estuary, nutrient budgets were constructed, leading to much lower export in areas with coarser grains and the microflora than the finer sediment areas of the system. These results indicate the importance of including this important but spatially-limited autotroph in nutrient dynamics modeling and mass balance estimates in shallow estuaries.

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A NUMERICAL STUDY OF SURFACE SEICHE RESPONSE TO HURRICANES ON LAKE OKEECHOBEE

Numerical simulations were performed using the model, CEST (Coastal and Estuary Storm Tide), to study surface seiche response to different hurricane on the Lake Okeechobee. The model was validated by simulation of Hurricanes Frances and Jeanne, occurring in September 2004. The modeled water level in the Lake agreed well with the measured data during hurricanes time. Thereafter, 19,200 tracks, with different path of the hurricane, maximum wind speed, hurricane moving speed, duration of impact, and the lake water level before hurricanes, were conducted to study the seiche height generated by different hurricanes on the Lake. The results indicated that the hurricanes toward the west-south-west direction are the seiche-prone path, which means that highest seiche heights were generated under the same category. Whereas, the hurricanes, toward the north-north-west direction, generated the lowest seiche height. The results also indicated that the category 3 hurricanes can produce seiche overtopping the dike under mean lake water level. The overtopping-prone zone of the dike located at the south-west and north-west shore.

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THE IMPACT OF TYPHOON “FUNG-WONG” ON THE DISTRIBUTION PATTERNS OF HEAVY METALS IN THE QUANZHOU BAY, CHINA

With the sharp increase of urban population and rapid develop of economy in recent twenty years around the Quanzhou Bay, a historic and developed urban bays located in the southeast of East China Sea Coast, the pollution was getting worse and seriously affected the ecological environment. Heavy metals, mainly discharged by Jinjiang River and rapidly deposited near the river mouth, are one of the major pollutants. According to long term records, four typhoons affect the Quanzhou Bay annually in average, which impact on the “secondary contamination” of heavy metals should not be ignored. Based on the inductively coupled plasma mass spectroscopy (ICP-MS) data of concentrations of 7 heavy metals (including Cr, Ni, Cu, Zn, Cd, Pb and As) in suspended particles and surface sediments collected at stations 13-hour-mooring stations in two surveys, conducted at an ordinary condition and 4 days after the landing of typhoon “Fung-wong,” which was the strongest typhoon in the East China Sea in 2008, respectively, in Quanzhou Bay. The contents and distribution of 7 heavy metals during a tidal cycle were illustrated and contrasted in two surveys. The contents of heavy metals, besides Ni, evidently decreased after typhoon but the distribution patterns were in emilar in two surveys in surface sediments. The contents of heavy metals were evidently increased with the distribution patterns varied obviously and differently individually due to their geographical position in the suspended particles after typhoon. The different of contents and distribution patterns of 7 heavy metals could be attributing to the “secondary contamination” and the increased supply of terrigenous materials during the typhoon process. This work was supported by the National Science Foundation of China (Grants no. 40806024).

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THE COMPLEX FRAMEWORK OF CHANGE: HOW SCIENTIFIC DATA FIT INTO THE DIVERSE SET OF CONSTRAINTS NECESSARY TO IMPLEMENT EFFECTIVE WASTEWATER MANAGEMENT POLICY

State and Federal regulatory agencies are charged with development and oversight of management strategies to address excessive nutrient loadings to estuarine systems. The Clean Water Act requires the development of these strategies based on the available science, which is often deemed insufficient by those required to make the financial and logistical outlay. The desire to predict with confidence the specific ecosystem responses and societal benefits that will result from the investment made is strong, while the tools available are often limited. Regulators also face the difficult task of weighing the benefits of additional scientific study against the cost of delayed action. In an effort to strike a balance many management strategies utilize an adaptive management approach where implementation and follow-up monitoring are used to inform subsequent management actions. As a result the need to develop and implement effective monitoring programs that will provide insight on the success of ongoing management actions and on the selection of future management
options is greater than ever. The success of adaptive management relies on initial phase management actions that are sufficient to produce measurable changes and monitoring programs that are sufficient to detect them. The coordination of these efforts is key to moving forward in this rapidly evolving field.

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CHANGES IN THE THERMOHALINE STRUCTURE FROM HOURS TO YEARS IN THE GULF OF FINLAND (BALTIC SEA)

The Gulf of Finland is a 400-km long and 80-120 km wide elongated sub-basin of the Baltic Sea. Its maximum cross-section depth decreases from > 100 m in the entrance in the west to < 30 m in the eastern part. The salinity distribution in the surface layer is characterized by an increase from east to west and a slight decrease from south to north. The water column in the deeper areas of the Gulf reveals a three-layer vertical structure in summer. The upper mixed layer, the cold intermediate layer and a saltier and slightly warmer near bottom layer can be distinguished. The latter layers are separated by the permanent halocline at the depths of 60-70 m. Our aim is to present the changes in summer thermohaline structure of the water column at three different time scales: years, weeks and hours. We use historical CTD data from 1987-2011, data of weekly surveys across the Gulf in 2006 and high-resolution CTD data acquired by an autonomous moored water column profiler in 2009-2011, respectively, to achieve these objectives. A clear difference in temperature and salinity was detected between the periods before and after mid-nineties in the deep layer of the Gulf, though the changes were not significant in the upper layer. The resulting long-term change in vertical stratification has influenced the oxygen conditions in the near bottom layer and release of phosphorus from sediments. Weekly surveys showed significance of mesoscale processes – a typical vertical thermohaline structure was occasionally modified by coastal upwelling and downwelling events, which in turn were responsible for vertical transport of nutrients and other substances. High-resolution profiling (time step of 3 hours) revealed remarkable temporal variations of the thermohaline structure, for instance, the upper mixed layer depth varied in a range of 5-33 m in July-August 2009. Stratification and its variations are suggested to be a key factor influencing the vertical dynamics of summer phytoplankton.

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LENGTH-WEIGHT RELATIONSHIP AND CONDITION FACTOR OF EPIFAUNAL FISH SPECIES ALONG BISCAYNE BAY SHORELINE, FLORIDA

Investigation of length and weight relationship has been of great importance in fish assessment and ecological studies. Data for length and weight can be useful information to predict the sustaining power of the fishery stock and can be a helpful tool for predicting the condition of fish. The present work is based on data collected in a monitoring project in Biscayne Bay designed to track the effects of water management changes in the Comprehensive Everglades Restoration Project. The aim is to report information about length-weight relationship and relative condition factors for seven most dominant and ecologically important epifaunal fish species along Biscayne Bay shoreline and relate them to salinity, which will be affected by water management. Length-weight relationships for the most dominant members of the nearshore forage-food community (Lucania parva, Floridichthys carpio, Gobiosoma robustum, Microgobius gulosus, Opsanus beta, Syngnathus scovelli, and Atherinomorus lineatus) are rare, incomplete or not available. Data were collected between January-February (dry season) and July-August (wet season) each year from 2005 to 2010. Sample size ranged between 110 (O. beta) and 5705 (L. parva) in dry season, 104 (S. scovelli) and 10409 (L. parva) in wet season. The value of the exponent b in the regression W=aL^b varied between 3.02 (L. parva) and 4.02 (M. gulosus), showed no significant difference between season (p>0.5), and indicated an allometric growth for most of the species. The relative condition factor for any species was not significantly different between seasons in any year (p=0.925). Most species were found within a salinity range of 18-34 (polyhaline-lower euhaline waters) and showed a significant correlation of condition metrics with salinity. The L. parva length-weight-relationship showed a significant correlation with salinity in both dry and wet seasons-G. robustum, only in dry season, and O. beta and S. scovelli, only in wet season.

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ASSESSING THE FATE, TRANSPORT, AND EFFECTS OF NUTRIENTS IN THE CHESAPEAKE WATERSHED AND IMPLICATIONS FOR THE CHESAPEAKE TMDL

The Chesapeake Bay Program has completed the first TMDL for a large aquatic ecosystem in order to meet tidal water quality standards in the Chesapeake. These standards were established in 2003 to restore the Bay’s living resources, and include standards for dissolved oxygen, chlorophyll, and the submerged aquatic vegetation (SAV) resource in shallow waters. The most sensitive standard, and the one that drove the TMDL allocation, was for dissolved oxygen in deep waters of the Chesapeake. Fueling deep water oxygen consumption are the nutrient loads delivered from the watershed and disposed, with overall average annual nitrogen inputs to the Chesapeake watershed estimated to be about 726 million kilograms from fertilizers, manures, legumes, and atmospheric deposition in the 1991 to 2000 period, as well as about 45 million kilograms from point sources. The average annual nitrogen loads estimated to be delivered to the Bay are about 122 million kilograms, or only about 16 percent of the total nitrogen inputs. Attenuation of the nitrogen inputs into in situ uptake, denitrification, storage of organic nitrogen in soils, and other loss mechanisms in the watershed. Overall estimated average annual phosphorus inputs to the watershed are about 97 million kilograms from the total inputs of fertilizers, manures, and atmospheric deposition, as well as about 4.5 million kilograms from point source discharges. An estimated 85.5 million kilograms of phosphorus were delivered to the Bay, or about 9 percent of the input phosphorus. The primary loss mechanism for phosphorus is sorption and storage in soils and watershed storage in deposition zones such as reservoirs. The fate, transport, and effect of these loads in the Chesapeake drive the pattern of nitrogen and phosphorus limitation in the estuary, and directly influences the TMDL allocation.

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GEORGIA OCEANS AND HEALTH INITIATIVE: A GRADUATE TRAINING CONSORTIUM IN OCEANS AND HUMAN HEALTH

Oceanic and coastal waters harbor and transport microorganisms and chemicals that cause disease or otherwise affect in humans and other animals. Additionally, as modulators of climate, the oceans indirectly influence disease patterns and the distribution of many pathogens. At the same time, the oceans are changing as a result of human activities: sea surface temperature is rising, fresh water supply to estuaries and coasts is being altered, chemical and microbial contamination increase, greenhouse warming, increased CO2 in the atmosphere is leading to greater uptake of carbon dioxide by
the ocean, which significantly reduces the pH of surface waters. How these changes will impact marine ecosystems is an area of active research. How these ecosystem changes will in turn affect human health is a largely unexplored field. The Georgia Oceans and Health Initiative (GOHI) graduate training initiative is an effort to respond to this need by training doctoral students to reach across traditional disciplines to better understand the linkages between the oceans and human health.

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LINKING STRUCTURE AND FUNCTION OF ANAMMOX BACTERIAL COMMUNITIES IN A TEMPERATE EUPTHIC ESTUARY

Anaerobic ammonium oxidation (anammox) and denitrification are two microbial nitrogen removal processes that control the intensity and duration of eutartine and costal eutrophication. Denitrification has been intensively studied while the role of anammox in estuarine ecosystems requires further exploration. Anammox, anaerobic oxidation of NO2-, coupled to the reduction of NO-, was shown to be controlled by substrate availability and temperature. However, it is unknown if the community structure of anammox bacteria affect their activities in the environment. In order to determine the linkage between structure and function of anammox communities, we investigated sediment communities in the New River Estuary, NC, a highly nitrogen enriched coastal system. Molecular analysis targeting the hydrogenoxidase (hzo) gene, a specific genetic marker for anammox bacteria, was conducted to examine structure of anammox communities. In tracer incubation experiments with sediment slurries were used to measure the rates of anammox and denitrification and estimate anammox contribution to total N2 production. Potential anammox rates ranged from 0.02 to 1.4 nmol N g-1 h-1. Anammox contributed up to 14% of total N2 production in estuarine sediments. Based on the hzo gene analysis, anammox bacteria related to “Candidatus Etttenia sp.” and “Candidatus Anammoxoglobus spp.” were widespread in estuarine sediments while “Candidatus Scalindua sp.” was found in lower part of estuary. Species response analysis to anammox rates showed high anammox rates were positively correlated to the presence of “Candidatus Etttenia sp.” while “Candidatus Scalindua sp.” had a negative response to the rates. This is the first study demonstrating the importance of “Candidatus Etttenia sp.” and “Candidatus Anammoxoglobus spp.” in the marine sedimentary N cycle and linkage between structure and function of anammox communities in estuarine and marine ecosystems.

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EFFECTS OF HYPOXIA ON PREDATION OF COPEPODS BY GELATINOUS ZOOPLANKTON IN CHESAPEAKE BAY

The main channel of the Chesapeake Bay is characterized by hypoxia (DO < 2 mg/L) bottom water from May to September. The goal of this research is to understand the effects of hypoxia on the distribution of scyphomedusae and ctenophores in Chesapeake Bay and predation pressure of these gelatinous predators on copepods. During cruises in May, August, and September 2010, we sampled gelatinous zooplankton every four to five hours at both stations and immediately preserved in formalin. Gut contents were identified and the tentacle bulb lengths of Beroe ovata were observed on the September cruise. M. leidyi and C. quinquecirrha were observed on the May cruise, high abundances of M. leidyi and Chrysaora quinquecirrha in August, and lower abundances of M. leidyi and C. quinquecirrha in September. In addition, many Beroe ovata were observed on the September cruise. M. leidyi and C. quinquecirrha were sampled from the surface, pycnocline, and bottom layer at both stations and immediately preserved in formalin. Gut contents were identified and the tentacle bulb lengths of individual ctenophores were measured to estimate wet weight. All data were analyzed with respect to hydrographic conditions and ambient zooplankton abundance to understand the predation impact of gelatinous zooplankton on copepods.

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EFFECT OF HYPOXIA ON PEPTIDE HYDROLYSIS IN SURFACE AND BOTTOM WATERS IN THE NORTHERN GULF OF MEXICO

Proteins and peptides account for a major fraction of cellular carbon and constitute most of the nitrogen in marine biota. Once released from marine biota, proteins and large peptides must be hydrolyzed by extracellular enzymes into small peptides and/or free amino acids to be taken up by bacteria. Therefore, peptide hydrolysis is a key link in nitrogen and carbon cycling in the marine environment. While we have gained much knowledge on peptide hydrolysis rates using fluorogenic substrates or large proteins, we know little about the pathways of small peptides and how they may differ between oxic and hypoxic waters. Here we provide insights on hydrolysis pathways of a tetrapeptide ala-val-pha-alata (AVFA) and a tripeptide val-phi-alata (VFA), both of which are fragments of the common protein Rubisco, in surface oxygenated and bottom hypoxic waters in the northern Gulf of Mexico. Our results indicate that in surface waters both the tetra- and tripeptides are hydrolyzed into individual amino acids by extracellular enzymes, while in bottom waters these small peptides are directly taken up by bacteria at a much higher rate than those in surface waters.

We hypothesize that the low-level of dissolved oxygen in bottom waters is the environmental factor that induces gene expression to produce permeases to transport small peptides across bacterial inner membranes. These data have important implications in the carbon and nitrogen cycles in the hypoxia zones, which are projected to expand significantly in the future.

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INTERANNUAL VARIABILITY: THE ELEPHANT AND THE BLIND MEN

Interannual variability remains a largely unknown quantity in coastal ecology. Due to the increased importance of recent issues such as Climate Change, long-term variation of aquatic systems has attained new importance. The climate question remains controversial due to difficulties of evaluating short-term weather events within the context of long-term climate alterations. Analyses of century-long changes of river flows in the Apalachicola drainage system (Florida) indicate recent increased length and intensity of droughts that have caused major changes in river-estuarine productivity. These changes in drought occurrence have led to the collapse of the highly productive coastal fisheries of an entire region.

Anthropogenic increases of nutrient loading in a series of coastal systems in the NE Gulf of Mexico have caused algal blooms that, in turn, have had adverse effects on fish and invertebrate populations. These blooms have caused reductions of fishery productivity of these systems. However, the understanding of bloom impacts is complicated by interannual changes of drought/flood cycles. Once again, Climate Change may influence these interactions. The lack of long-term background data in the Gulf of Mexico relative to the recent BP oil spill has increased the difficulty of adequate impact evaluations. Interpretation of the results of short-term studies can only be evaluated within the context of the long-term climatological conditions that prevail in a given area. An understanding of the interactions of long-term changes of climatic factors with anthropogenic activities is critical to impact evaluations and restoration efforts in degraded coastal ecosystems. The general avoidance of understanding interannual variation in coastal ecology has led to serious problems of interpretation and response. The elephant/blind men parable comes to mind.

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RESTORATION AND DEGRADATION TRAJECTORIES OF THE BENTHIC COMMUNITIES OF CHESAPEAKE BAY

The Chesapeake Bay is North America’s largest estuary. From European colonial times until the present, the watershed has been altered from a highly forested, riparian buffered and minimally impacted ecosystem to an ecosystem where agricultural, industrial and municipal insults dominate and overwhelm natural stressors. Contrary to natural stressors, anthropogenic stressors, alter the nature of ecosystem evolution, stasis or adaptability. Protective and restorative ecosystem actions must be by necessity compromise economic, cultural and ecological values. In our presentation, we present results concerning changes in the benthic community condition of Chesapeake Bay, USA, relative to restorative efforts to significantly (1) reduce nutrient loads and minimize eutrophication effects—primarily ecosystem-wide alterations from low dissolved oxygen events, (2) increase water clarity to promote increases in submerged aquatic vegetation—increasing the nursery/refugia benefit of shallow water vegetation, and (3) decrease contaminant effects in urban ecosystems to promote increases in submerged aquatic vegetation – increasing the nursery/refugia benefit and overall urban ecosystem quality. We present results from the most spatially intensive benthic monitoring program in the USA that has now sampled the Chesapeake Bay for 15 years. Our emphasis was to account for any
possible flow effects that might effect observed trends such that the residual trends might be better related to management actions. Our results indicate significant increase degradation of benthic community condition in the mesohaline region of the Bay and the Patuxent River and improving benthic community condition in the Potomac River, Elizabeth River and the Maryland Western Tributaries. There were no trends in benthic community condition or flow effects in the James, York and Rappahannock rivers.

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CHARACTERIZING GEOCHEMICAL OTOLITH SIGNATURES TO DISCRIMINATE BETWEEN DOLLY VARDEN POPULATIONS (Salvelinus malma) FROM THE YUKON-TERRITORY AND NORTHWEST TERRITORY, CANADA

Northern Dolly Varden (Salvelinus malma) that inhabit western Canadian Arctic rivers are thought to be highly dependent upon thermal and non-thermal springs for spawning, rearing and over-wintering habitat. Evidence thus far suggests that rivers fed by thermal or non-thermal springs have different geochemical and isotopic compositions. Five river systems located in the study region, are utilized for the purpose of characterizing otolith elements and geochemical signatures: Vittekwa River, Rat River (Little Fish Creek), Big Fish River (tributary Cache Creek), Babbage River (tributary Fish Hole Creek), and the Firth River (tributary Joe Creek). Trace element composition of otoliths from Dolly Varden utilizing these critical habitats particularly for spawning and rearing should reflect distinct variation between thermal and non-thermal springs as well as variations in the geological character of the surrounding environment. Using laser ablation-ICP-MS we assess otolith microchemistry and isotope as tools to discriminate between populations of Dolly Varden from the Yukon Territory and Northwest Territories. Sagitall otoliths will be analyzed for 17 elements by laser ablation-ICP-MS techniques: 70thium, 90beryllium, 11boron, 60nickel, 65copper, 66zinc, 88strontium, 137barium, 23magnesium, 27aluminum, 82rubidium, 31phosphorus, 32sulfur, 39potassium, 55manganese, 58iron and standardized to calcium. For comparison to otolith elemental and isotopic analyses, water samples collected from rivers within the study region were examined for similar trace elements and isotopes. Independent multivariate analyses for otolith element and isotopes and geochemical signals will be used to discriminate between fish populations/river systems. Differentiation of Dolly Varden populations will provide further evidence of philopatry or dispersal and ultimately aid in determining classification of fish captured in mixed-stock coastal fisheries.

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COASTAL WATERSHED RESEARCH FOR UNDERGRADUATE STUDENTS AT FLORIDA GULF COAST UNIVERSITY

Florida Gulf Coast University is a regional comprehensive university located in Southwest Florida whose mission encompasses the practice and promotion of environmental sustainability, public service and civic responsibility. Within the Marine Science program, we share the belief that interdisciplinary collaboration and scholarship enhance our individual research activities and benefit our students. Currently, undergraduate research at FGCU is offered and managed at the programmatic level. All FGCU undergraduate science students begin their junior year by taking a class that requires them to design and write a research proposal. In Marine Science, undergraduate research is accomplished through internships or senior research projects. In addition, research is also integrated into upper-level courses. Most of our upper-level core and elective courses have research components, while field-based courses have heavily weighted research components. Mentorship of students in our labs is cross-disciplinary with undergraduates coming from programs such as Biology, Chemistry, Environmental Studies and Environmental Engineering. Students participate in a diverse variety of research activities ranging from field studies to complex, state of the art analytical techniques in the laboratory. Students are involved with research that is a result of collaborative efforts between one or more faculty, allowing them to appreciate the complexity of coastal environments and to value different approaches to answering a question. Southwest Florida’s estuaries are critical to the health of the coast and adjacent ocean. These estuaries are highly impacted by what occurs upstream in the watershed. As such, this area provides a good model for involving our students in research activities, both within the context of a class or as a research project.

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ENHANCING BIODIVERSITY ON COASTAL DEFENSES THROUGH ENGINEERING TOPOGRAPHIC HETEROGENEITY

Increasing urbanisation in Singapore has resulted in widespread replacement of natural habitats with man-made ones such as seawalls, pier-pilings and breakwaters. These coastal structures, which are often erected on or near coral reefs, tend to support biological communities with low biodiversity; possibly because they are less complex and heterogeneous compared to natural habitats. Habitat structure is often a limiting factor for species diversity, especially at small spatial scales. To test if topographically more heterogeneous substrates will support greater biodiversity, we designed two types of concrete tiles with approximately equal surface areas, one structurally more heterogeneous than the other, plus a control tile made of granite. To quantify the amount and variety of space available, we created four different geometric designs and then used a simple algorithm with a fixed mean value to randomly vary the size, depth and spacing of each component for the “heterogeneous” tile design. The “simple” tiles had components with equal size, depth and spacing of the same fixed mean. The concrete tiles (n = 8) were then mounted onto steel frames which were in turn fixed onto granite seawalls (at two tidal heights) adjacent to coral reefs at two islands south of Singapore. Colonisation of the tiles is being monitored every four weeks and, one year after installation, composition of the assemblage will be compared among tile type, shore height and island.

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INTERACTIVE EFFECTS OF ENRICHMENT AND THE MANIPULATION OF INTERMEDIATE HOSTS ON INFECTION PREVALENCE AND FOOD WEB STRUCTURE

Parasites with complex life cycles frequently increase their transmission to definitive hosts (where reproduction occurs) by increasing the susceptibility of intermediate hosts to predation by definitive hosts. While recent evidence finds that anthropogenic driven habitat alterations can alter host-parasite relationships, whether such alterations interact with intermediate host manipulation to influence infection prevalence and food web structure remains unknown. We develop a nutrient-limited food web model to investigate how manipulation of intermediate host susceptibility, nutrient supply, and predator diversity determine parasite abundance and infection prevalence in intermediate and definitive hosts. We show that the effects of intermediate host manipulation on parasite abundance and infection prevalence depend on enrichment while the coexistence of competing definitive hosts and “dead-ends” (where parasites cannot reproduce) depends primarily on intermediate host susceptibility. Our results suggest that anthropogenic changes in nutrient supply will interact with host-parasite relationships to determine parasite abundance, infection prevalence, and food web structure.

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THE HEDGEHOG AND THE FOX: A PERSPECTIVE FOR ECO SYSTEM BASED MANAGEMENT

Berlin (1953) tells a story about hedgehogs and foxes. The hedgehogs know one big thing and apply that one thing everywhere. They tend to express much confidence in their own views while simultaneously dismissing opposing viewpoints. Foxes, in contrast, tend to know many things. They are more likely to consider multiple competing views, make bottom-up arguments from an array of facts, and are cautious when presented with big ideas. At one extreme, hedgehogs seek certainty and closure, dismiss information that undercuts their preconceptions and instead embrace evidence that reinforces them, in what is called belief defense and bolstering. At the other extreme, foxes are cognitively flexible, modest and open to self-criticism. They welcome and seek diverse information and views. Traditionally, resource management has been single discipline based, with participants being more like hedgehogs than foxes. Ecosystem-based management, when fulfilling its promise, should have its participants being more like foxes than hedgehogs. Unfortunately, while we all agree that an interdisciplinary approach is needed, we still tend to be hedgehogs despite our best intentions. This is particularly significant in the case of ecosystem-based management, and especially so for delivering ecosystem services. This is where the human dimensions and the bio-physical dimensions meet, and where behaving like foxes is even more important. This presentation will focus on a contemporary version of the hedgehog and fox, the concept of integrative complexity, and how it relates to ecosystem-based management. It will present a perspective on the inherent complexity of trade-offs associated with ecosystem services, and how an understanding of integrative complexity can help managers and researchers better grasp what is needed to effectively work through our coastal challenges, and meet the preferences of society via ecosystem services.
ROS accumulation. By using a combination of fluorogenic probes and a newly developed ROS-chemiluminescence assay we provide insight into the kinetics and abundance of ROS produced in seagrasses during the early stages of infection.

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LINKING ECOSYSTEM SERVICES WITH HEALTH AND WELL-BEING IN THE WAKE OF THE DEEP WATER HORIZON INDUSTRIAL DISASTER

While the magnitude of the environmental impacts resulting from the Deepwater Horizon industrial disaster are being analyzed for the Gulf region, so too are the social, cultural, economic and health impacts to coastal communities. Already, evidence suggests that communities have been affected in many social areas which will serve to deteriorate the long-term well-being of impacted communities, reducing the quality of life for coastal residents. Collecting information about components of well-being including health, basic human needs, economic security, environmental integrity and subjective well-being can capture the cumulative impacts to and responses of communities to this crisis. Human communities having strong ecologically-based social relationships are the most vulnerable to industrial disasters because destruction of natural resources disrupts every facet of community life, from interpersonal relationships to economic and community activities and networks. Evidence from past industrial disasters indicates that the human communities relying on these ecosystems will be compromised. To describe the connections between environmental condition and well-being requires identifying measureable indicators that are mediated directly or indirectly through the links. Conceptual models that delineate these specific connections offer an opportunity to understand and where interventions may protect well-being. As part of a study to monitoring changes in the health and well-being of residents in counties along the Gulf of Mexico impacted by the Deepwater Horizon industrial-environmental disaster we brought together an expert group with representatives from agencies and institutions experienced in measuring well-being and in working in the Gulf region. Using their guidance, along with literature review and other expert opinion we have developed models and measures to better define the relationships of health and well-being of communities and ecosystems.

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FISHING IMPACTS ON MID-TROPHIC LEVEL SPECIES IN COASTAL FOODwebs: FISHING UP THE FOOD WEb?

Fishing has been suggested to cause a decline in the average trophic level of the ecosystems (Pauly, Christensen et al. 1998). Here we report the impacts from an inshore fishing activity (shrimp trawling) that increased average trophic levels due to removal of the mid-trophic level target species (penaeid shrimp, effective trophic level or ETL = 2.5–3.4) by by-catch species (pinfish, ETL = 2.1, spot ETL=2.6). The impact of this shrimp trawling fishery, in which there is also the presence of other species with a higher trophic position (southern and gulf flounders ETL = 3.6, spotted seatrout ETL = 3.9, black seabass ETL = 4.2), results in a higher average trophic level for species in areas that are open to trawling compared with areas that have been closed to trawling by state regulations for more than 30 years. The results are confirmed by both food web network models (ECOPATH, effective trophic levels) and stable isotope ratios (A15N ). Removal of penaeid shrimps, which are meso-trophic-level species and have high network “betweenness”, can reverse the fishing impacts of conventional fisheries, which often target the highest trophic levels first. Because invertebrate fisheries are based on shrimps that have high market value, but mid-trophic level position, there are indirect trophic effects that cascade upwards and downwards. If the removal of mid-trophic level species continues long-term, many years, the high-trophic level species experience a decline in their forage base, and are forced to consume alternative prey, producing longer average path length and trophic cascades that may have unintended impacts. The ecosystem wide impacts of removal of mid-trophic level species will be explored using visualizations and simulations.

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THE EFFECTS OF OIL POLLUTION ON AQUATIC PRIMARY PRODUCTIVITY OF A LOUISIANA COASTAL ESTUARY

In order to determine potential effects of the Macondo 252 Oil Spill in the Gulf of Mexico on the aquatic primary productivity in estuaries of coastal Louisiana, phytoplankton
productive was measured seasonally for several locations located along a salinity-turbidity- nutrient gradient using the light, semi-shaded and dark bottle oxygen technique in a field incubator. The impacts of petroleum hydrocarbons were measured by adding 100 ppm of oil from the spill to a subset of the light-dark bottles. As expected, oxygen production decreased with decreasing light availability, though there was little difference between the dark and more heavily shaded bottles. Oxygen production was lower in oil-spiked samples relative to non-spiked samples when light availability was high. However, under low-light conditions, there was little to no difference in oxygen production between oil spiked samples and non-spiked samples. Further analyses of these data, including seasonal variations, will be presented at the conference.

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HYDROLOGY OF RESTORED ATLANTIC COAST AND CHESAPEAKE BAY GRID-DITCHED MARSHES

Ditch plugging is a low-impact method of restoring marshes but its effects on hydrological regime and ecosystem services has not been widely been determined. The goal of this project is to assess hydrological responses to ditch-plugging on Atlantic Coast and Chesapeake Bay marsh ecosystems. Four marsh sites (Deal Island, Somerset County; EA Vaughn, Worcester County; Assateague State Park, Worcester County; Assateague National Park, Worcester County) will be used in the study with a before, after, control, and intervention design. Sites will be monitored for one year prior to intervention. We will assess for hydrological and ecological properties of the sites including ditch intensity, water quality, water table fluctuations and interaction with surfacewater, salinity profiles, vegetation composition, and mosquito community composition and densities. The main objectives of the study are to identify and compare pre- and post-plugging characteristics; determine restoration ecological effects; and identify site variables that can be used to predict the success of future ditch-plugging restoration projects.

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ACROPORA RESTORATION IN FLORIDA AND THE U.S. VIRGIN ISLANDS

Due to significant declines in living coral cover within the Florida Keys National Marine Sanctuary (and worldwide) due to a variety of threats, many associated with changes related to global climate change, the need for active restoration of coral reefs has become apparent. In 2009, under the American Recovery and Reinvestment Act, NOAA recognized this need and funded a large-scale coral restoration project. The aim of this project is to enhance degraded coral reefs throughout Florida and the U.S. Virgin Islands. The long-term goal is to increase larval production and genetic diversity by increasing the likelihood of successful cross-fertilization between genetically distinct colonies located on outplanted restoration sites. To date, nurseries have been maintained or established within eight distinct subregions with the purpose of propagating the species and creating as many new colonies as possible. Nursery-reared corals will be transplanted onto reefs that are known to have supported acroporid communities, with the hope that these corals will contribute to the reseeding of natural reefs. This project represents an active form of coral reef management. The end goal is to strategically outplant at least 5,000 coral colonies to reefs that once supported large thickets of acroporid corals throughout South Florida, the Florida Keys and the U.S. Virgin Islands. Through careful site selection, this outplanting could help to increase the chances of successful sexual reproduction, thereby encouraging the reseeding of natural reefs. Additionally, the nurseries have served as a repository of genotypes, as was the case in the winter of 2010 when fragments in the nursery survived even as their wild parent colonies died.

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DOES MIXING CONTROL ESTUARINE EXCHANGE?

The estuarine exchange flow depends upon turbulent mixing of river and ocean water. The Knudsen relation tells us that greater mixing increases the inflow, often amplifying it to many times greater than the river volume transport. Barocolnic exchange through any section may be limited by hydraulics or by the complex interactions of tidal currents with bathymetry. Looking at this as an energy balance, the mixing is quantified as buoyancy flux. The exchange through a section is a combination of (i) advective flux of baroclinic potential energy, and (ii) pressure work. Here we combine these to show that the net buoyancy flux governs the density of the outflowing water. These theoretical results are explored using a realistic numerical simulation of Puget Sound.

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THE SHORELINEVIDEO ASSESSMENT METHOD (SVAM); A NEW TOOL FOR ASSESSING SHORELINE MANGROVE BIOMASS, BIODIVERSITY, CONDITION AND THREATS AND QUANTIFYING CHANGE OVER TIME

The Shoreline Video Assessment Method (SVAM) has been designed to meet the growing need for holistic, large-scale assessment of mangrove shorelines and coastlines, and to address limitations in currently utilised mangrove ecosystem assessment techniques. The SVAM approach uses continuous geo-tagged digital video imagery of coastlines and estuary shorelines to conduct criteria-based assessment of fringing mangrove forest structure, condition and biomass, shoreline processes and both natural and anthropogenic disturbances. This approach has so far been adopted for assessment of coastal erosion impacts in Vietnam, fringing mangrove biomass quantification in the Solomon Islands and as part of a community based long-term mangrove monitoring program (MangroveWatch), in Australia. Here we present a detailed assessment and review of the accuracy, strengths and limitations of the SVAM approach by comparing data collected in fringing mangrove plots with the results of SVAM assessment in three different locations; Daintree and Barm Rivers in Queensland, Australia and Roviana Lagoon, Solomon Islands. Additionally, observer-based error and bias in video assessment is quantified using multiple assessors. Preliminary findings suggest that SVAM is an excellent tool for assessment of extensive and dynamic fringing mangrove ecosystems, providing detailed information at a spatially relevant scale, with multiple applications ranging from carbon stock quantification to community coastal monitoring programs. Results show that the full power of SVAM is realised when used in conjunction with existing remote sensing and plot-based approaches and in the context of a standardized approach to stressor identification. Use of SVAM in addressing mangrove and broader coastal management issues, will greatly increase our capacity to address the significant challenges of coastal zone management presented by sea level rise, population growth and coastal development.

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INTERACTIVE EFFECTS OF GRAZING AND NUTRIENT ENRICHMENT ON SEAGRASS (THALASSIA TESTUDINUM) CONDITION

Eutrophication is a major concern because of its potential to alter community structure and function. As a result, early detection of nutrient loading is of primary importance. Seagrasses have been viewed as biocriteria because they integrate water conditions over time and respond to changes in nutrient regimes; however, tissue nutrient contents and growth dynamics of primary producers are sensitive to other factors, like grazing, that may confound interpretation as indicators of nutrient enrichment. We conducted a study in Big Lagoon, FL to examine whether grazing and nutrient enrichment similarly impacted seagrass tissue nutrient concentrations and growth dynamics, thereby diminishing their use as indicators. Fertilizer additions were used to simulate eutrophication, and manual clipping of seagrass blades mimicked vertebrate grazing. Fertilizer additions successfully elevated water column concentrations of NH4+, NO3-, and PO4-3 in fertilized beds, although concentrations diminished over time. Initial leaf growth rates in both clipped and fertilized+clipped treatments averaged nearly 1 cm d-1, but growth rates in fertilized+clipped beds (-0.1 cm d-1) were lower than in clipped beds (0.1 cm d-1) after 40 d. The effects of fertilization and clipping on biomass varied among the treatments with fertilized beds experiencing increased biomass (170 ± 320 g); while biomasses in control (-280 ± 390 g), clipped (-26 ± 250 g), and fertilized+clipped (-480 ± 290 g) beds declined. Tissue N content increased in response to fertilizer treatments, but grazing had little effect on CN ratios. These results suggest that the growth response of seagrass to eutrophication is...
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CONTROLS ON TRANSPORT OF SUSPENDED SEDIMENT INTO AND OUT OF THE ESTUARINE INTERTIDAL ZONE

Field measurements of velocity, water properties, and suspended sediment concentration were collected in a region spanning the estuarine intertidal and subtidal zones in northern San Francisco Bay during the spring of 2011. The objective of this research was to investigate the controls on sediment fluxes across the subtidal/intertidal interface, which is along the pathway between an estuary’s axis and fringe habitats. Drying in intertidal regions makes transport possible only intermittently, and therefore the interaction between tidal stage, advection, and sediment resuspension by wind waves and currents differs between subtidal and intertidal locations. This research examined the transport of sediment that resulted from two correlations: (1) water depth with the tidal processes of stirring and advection, and (2) water depth with irregular wind forcing. The direction and magnitude of transport depend on the interaction between concentration, velocity, and flow depth. The nature of the tidal wave (i.e., standing vs. progressive) controls the phasing of velocity relative to depth, and in the absence of meteorological events, tidal stirring largely determined the sediment concentration. This tidally-driven transport was investigated on diurnal and spring-neap timescales to establish a baseline of subtidal/intertidal fluxes. The second correlation captured the perturbation to the baseline caused by wind-wave-driven resuspension and its dependence on water depth, where depth must be greater than zero, but shallow enough to transmit wave energy to the bed. When wind occurred at this range of tidal stages, advection was altered compared to the purely tidal case and transport was changed, reflecting the interdependence of the effects of tides and meteorological forcing on net sediment transport. The results of this work inform scientific and practical questions about the viability of perimeter estuarine habitats.

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LINKAGES OF WATERSHED-ESTUARY PROCESSES IN FLORIDA BAY: MANAGEMENT AND CHANGE

Introducing a session on watershed-estuary linkages, this discussion focuses on how the stresses impacting watersheds are manifest in downstream estuarine waters. Examples from the highly engineered Everglades-Florida Bay, FL ecosystem show how a synthesis of targeted models can be used predictively and to bound restoration alternatives. Altered hydrology, land use, urban and agricultural development and consumptive water use have impacted coastal Florida waters during the past century. Natural temporal change, including climate and sea level patterns, create a dynamic baseline. Stochastic perturbations such as droughts and tropical storms can have system-shifting effects that persist for years or decades. Spatially, estuaries represent interfaces between complex boundary conditions including fresh-salt, marine-riverine, human-natural, terrestrial-aquatic realms where gradients are often intense, compressed, extremely interactive, and where biotic responses are unpredictable. Florida Bay is managed by regulating hydrology and effluent flow upstream. Most of the external phosphorus input is from marine and atmospheric sources. Nitrogen is more prevalent in upstream sources. N species and nutrient stoichiometry are key factors determining the mix and distribution of autotrophic production that occurs in downstream waters - pelagic/benthic, algal/vascular, planktonic/fixed; micro/macro. Nutrient control and residence time also regulate species composition, potential for algal blooms, and epiphyte and algal overgrowth. Understanding the sensitivity of the downstream system to stresses and the propagation of change through the ecosystem is critical to choosing effective options for ecosystem maintenance and restoration. Models linking ground and surface water hydrology, 3-D hydrodynamics, biogeochemistry, trophodynamics and ecology are used to analyze sensitivity, resilience and resistance to change in Florida Bay in the context of local, regional and global dynamics.

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THE IMPACTS OF EXPLOITED HIGHER-ORDER CONSUMERS ON THE STRUCTURE AND FUNCTION OF A SPECIES-RICH COMMUNITY

Marine higher order consumers can exert a strong community-wide influence over the intensity of trophic interactions and relative abundances of lower order consumers (i.e., trophic cascades) in simple food webs. As such, significant reductions in the numbers and kinds of these typically large voracious predators should trigger important changes in the structure and function of most marine food webs. A number of recent field and modeling studies, however, have failed to detect evidence of strong community-wide trophic cascades in species-rich tropical marine systems. These ecosystems are best characterized by a long history of intense fishing throughout every trophic level. It remains unclear if the persistence of these historical food web reorganizations into the modern day explains the paucity of community-wide cascades in these ecosystems. Using data collected from visual censuses reported in Valentine et al. (2008), we built a scaled tropical food web in simulations that modeled the impacts of piscivores on lower order food-web interactions. We manipulated densities of unexploited and exploited predators (horse-eye jack and black grouper respectively) to develop a mechanistic understanding of why community-wide trophic cascades may be hard to detect in tropical systems. To do this, we offered herbivores and invertivores preferred food items while being exposed to risk of attack by exploited and unexploited piscivores singly and in combination. Trials were digitally recorded for further analysis of species interactions as well as behaviors. The results of this experiment show that complementary piscivore foraging strategies as well as presence of exploited piscivores are key determinants of the strength of top down impacts in species-rich communities.

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HERDING CATS: IS IT POSSIBLE TO REACH AGREEMENT ON GOALS FOR SOUTH FLORIDA’S COASTAL ECOSYSTEMS?

Large-scale restoration and protection of coastal resources to preserve economic, aesthetic and cultural values and, in some cases, to protect human health, requires the identification of quantifiable goals that are strongly supported by broad sectors of society. Establishing quantifiable and attainable goals requires an open dialogue between concerned citizens, community leaders, industry, coastal managers, and scientists. This dialogue is a stepwise, iterative process that begins with identifying qualitative ecosystem goals or states (e.g. healthy fish population, clean water). These qualitative goals are then translated into quantitative goals (e.g. specific abundances of fish species, specific water quality measures). If broad agreement is eventually reached on quantitative goals, and these are adopted by the local and state authorities responsible for coastal resources, they can be used to drive focused research to provide managers with the tools they need to confidently manage the stressors that impact attainment of their goals. Beginning in 2009, MARES, the NOAA-supported Marine and Estuarine Goal Setting for South Florida project, has taken just such an approach with the goal of reaching a science-based consensus about the defining characteristics and fundamental regulating processes of a South Florida coastal marine ecosystem that is both sustainable and capable of providing diverse and ecological services upon which our society depends. MARES is utilizing a number of techniques including integrated conceptual ecological models, quantitative ecosystem indicators, public meetings/workshops, and social science tools to bridge gaps in understanding, perceptions and goals in order to reach a consensus that is sufficient to effect changes in current practices in order to sustain valued coastal resources.

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MARES ELECTION RESPONSE TO SEA LEVEL RISE ON LONG ISLAND, NY

Over the time period measured in this study (three years), marshes at five locations on the eastern end of Long Island have increased in elevation faster than the historic rate of sea level rise as measured by the closest tide gauge at Montauk Point, NY. However, all of these marshes are increasing in elevation more slowly than the short-term rate of sea level rise measured at that same tide gauge for the time period of this study. Further measurements of elevation change, sediment accretion, porewater chemistry, hydrologic patterns, root respiration rate, and belowground root and rhizome production will help determine whether marsh elevation deficits are from a disruption in mobile sediment supply or subsurface processes. We are working with partners to solve this puzzle. Conservation strategies will focus on the key threats identified in this study.

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THE NATURAL RESOURCE ADVISOR PROGRAM: AN INNOVATIVE APPROACH TO PROTECT NATURAL AND CULTURAL RESOURCES DURING THE DEEPWATER HORIZON OIL SPILL RESPONSE

The Deepwater Horizon (MC252) oil spill response required the removal of oil from the affected shorelines of Louisiana, Mississippi, Alabama, and Florida. Many of the shoreline communities, which are located along the pathway between an estuary's axis and fringe habitats, were affected shorelines of Louisiana, Mississippi, Alabama, and Florida. Many of the shoreline
clearup activities had the potential to cause inadvertent but significant impacts to natural and cultural resources. As part of an emergency section 7 consultation, the USFWS developed a list of Best Management Practices (BMPs) to be implemented to minimize the impacts to federally listed species, designated critical habitat, and candidate species. The Deepwater Horizon SCAT group integrated these BMPs into their Shoreline Treatment Recommendations but, due to the size of the response area (>1000 miles), it was difficult for the SCAT to ensure compliance throughout the entire response while fulfilling their primary duties. Thus, the Mobile Unified Command, in close coordination with SCAT, USFWS and the NPS, developed an innovative approach, the Natural Resource Advisor (NRA) program, to oversee compliance with agency BMPs and assist operations crews in minimizing potential injury to natural and cultural resources. The NRA program was comprised of 100 professional biologists distributed throughout the response area and embedded within the field operations crews. NRAs delineated sensitive natural and cultural resources, directed clearup crews and mechanized equipment away from these areas, and advised field operations on the least intrusive locations for staging and ingress/egress to the beach. The NRA program was extremely successful and achieved the primary program goal of assisting field operations personnel with BMP compliance. It provided state and federal agency personnel with a single point of accountability for natural and cultural resource issues, collected data for the section 7 administrative record, reduced NRDA liability, and, most importantly, minimized impacts to the Gulf of Mexico shoreline during this historic response.

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BACTERIAL SOURCE TRACKING GUIDES MANAGEMENT OF BOAT WASTE IN A COASTAL RESORT AREA

Fecal contamination of water bodies causes a public health problem and economic loss; however, management actions to control such contamination need to be guided by sound science. From 2007-2009 a study was undertaken by the University of North Carolina Wilmington to determine the sources of fecal bacteria contamination to the marine waters adjoining the Town of Wrightsville Beach, North Carolina. Analyses included sampling for fecal coliform and Enterococcus bacteria, sampling for optical brighteners, dye studies for water movement analysis, and use of molecular bacterial source tracking techniques including polymerase chain reaction (PCR) and terminal restriction fragment polymorphism (T-RFLP) fingerprinting of the Bacteroides-Prevotella group. Of 96 samples collected from nine locations during the study, the water contact standard for Enterococcus was exceeded on 13 occasions. The T-RFLP fingerprint analyses demonstrated that the most widespread source of fecal contamination was human, occurring in 38% of the samples, with secondary runnient and avian sources also detected. Optical brightener concentrations were low, reflecting a lack of sewage line leakage or spills; thus evidence pointed toward discharge from boat heads into the marine waters as the major cause of fecal contamination. Based on the research data, the town and other communities initiated action to have the U.S. EPA declare the coastal waters, the nearby Atlantic Intracoastal Waterway and tributaries a non-discharge zone for boat heads. The actions resulted in allowable sewage to alleviate the historical pollution. In early 2010 this action passed successfully through the Federal comment process and has enabled these waters to become the first marine area on the U.S. seaboard between Delaware and the Florida Keys to be declared a non-discharge zone.

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EFFECTS OF THE MAGDALENA RIVER RE-COMMUNICATION WITH ITS FORMER DELTA: CHANGES IN THE PHYTOPLANKTONIC PRIMARY PRODUCTION AND RESPIRATION IN THE PAJARALES COMPLEX, 1989 TO 2005

The phytoplankton primary production, pelagic respiration, photosynthetic pigments, and physical-chemical associated variables in the Pajarales Complex, were estimated to assess the potential effects of the Magdalena River re-communication with its former delta. The study carried out between September and December 2005, followed the same experimental design than done in 1989 in order to the re-communication. The results show a significant increase of the net primary production when compared with the years 1988-89 (from 598 g C/m²/year to 982 g C/m²/year). The actual production seems to be driven mainly by ammonia, and there is no correlation neither with the water transparency nor the chlorophyll a concentration. The ecosystem is less efficient in the synthesis of organic matter after the re-communication with the Magdalena River. The respiration rate increased, showing higher and more prolonged heterotrophy, which may be associated to higher organic matter and inorganic nutrient inputs from the Magdalena River. The results confirm eutrophication increase in the Pajarales Complex between 1989 and 2005.

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DISTRIBUTION OF TROPICAL SEAGRASS SPECIES IN BERMUDA IN RELATION TO LIGHT AVAILABILITY

Surveys were undertaken on the shallow Bermuda marine platform between 2006 and 2008 to assess the depth distribution of seagrasses in relation to the marine littoral regime. Bermuda is located in temperate latitudes but seagrasses are common in the shallow waters of the platform. We found that the relatively slow-growing and long-lived seagrass Thalassia testudinum is restricted to habitats with much higher light availability than in the tropical locations where this species is commonly found. In contrast, the faster growing tropical seagrasses in Bermuda, Syringodium filiforme, Halodule sp and Halophila decipiens, had similar ecological compensation depths (ECD) as in tropical locations. Increasing sea surface temperatures, concomitant with global climate change, may either drive or allow the poleward extensions of the ranges of such tropical species. However, due to latitudinal light limitations at least one abundant and common tropical seagrass, T. testudinum, is able to occupy only shallower depths at the more temperate latitudes of Bermuda. We hypothesize that the poleward shift of seagrass species ranges would be accompanied by restrictions to even shallower depths of T. testudinum and by very different seagrass community structures than in tropical locations.

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BIOMASS AND PRODUCTIVITY OF ARCTIC AND SUB-ARCTIC ASCOPHYLLUM NODOSUM POPULATIONS

We quantified the biomass, annual growth and productivity of five populations of the intertidal seaweed Ascophyllum nodosum around the northern distribution limit of this species (from 64 degree N to 69 degree N, coasts of Western Greenland and Lofoten, Norway). Standing biomass per unit of area ranged between 4500 gDW m-2 and 6800 gDW m-2, and was similar to that of populations growing further south. The architecture and life
span of the species enabled us to retrospectively quantify seaweed annual growth rate for the last decade. Average annual growth rate of A. nodosum populations ranged between 2 and 6 cm yr\(^{-1}\), the slowest elongation rate recorded for this species. Annual tip elongation rate of Arctic and Sub-Arctic populations also varied inter-annually during the last decade. Further, comparison of A. nodosum growth rate along its geographic range of distribution revealed that growth is closely dependent on seawater temperature, and increases by 0.80 cm per degree C of summer seawater warming. When comparing temporal fluctuations of A. nodosum growth rate with time series of the duration of the annual ice-free period at the sites studied, it became apparent that growth and productivity of A. nodosum may increase along the Arctic and Sub-Arctic coasts in response to the global warming projected by the IPCC scenarios.

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SEAGRASS DIEBACK IN A SHALLOW LAGOON: PATTERNs OF EPIPHYTIC NITROGEN FIXATION WITH EUROTrophic

We have been studying nitrogen fixation and associated biogeochemical feedbacks in a shallow, eelgrass-dominated ecosystem (West Falmouth Harbor, MA, or “WFH”) since 2005. Nitrogen inputs from the watershed have increased some 3.6-fold since 1999 due to increasing anthropogenic disturbance over the last few decades has increased the frequency, duration and intensity of harmful algal blooms (HABs) worldwide. In southwest Florida, the Caloosahatchee estuary is a highly managed riverine system where freshwater inflow can be negligible in the dry season (winter-spring) and extremely high (5000 cfs) in the wet season (summer-fall). As freshwater inflow is a main controlling factor of both nutrient and light availability for phytoplankton in the Caloosahatchee estuary, phytoplankton growth can vary greatly throughout the year. We collected monthly plankton samples from 2008 to 2010 at 14 locations along the Caloosahatchee estuary from the Franklin lock and dam (S-79) to the river mouth. Phytoplankton were identified to the lowest taxonomic level possible and quantified as cells/L and cell volume/L. Blooms were evident year round, occurring upstream when freshwater inflows were low and further downstream as rates of discharge increased. Common bloom species included Skeletonema costatum, S. tropicum, Pseudo-nitzschia pungens, Cerataulina sp., Akashiwo sanguinea, and Gonyaulax polygramma. Cyanobacteria blooms (e.g. Microcystis) were more common during high flows. As several of these species have caused HABs in other areas, these species need to be considered in the management of freshwater inflow from S-79 in order to minimize the threat of HABs in the Caloosahatchee estuary.

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LINKING BIOGEOGRAPHIC AND LIFE HISTORY INFORMATION FOR NONINDIGENOUS MARINE AND ESTUARINE SPECIES IN THE NORTH PACIFIC: AN INTRODUCTION TO THE PACIFIC COAST ECOYSTEM INFORMATION SYSTEM (PCEIS)

Estuaries and near-coastal waters throughout the world continue to face the threat of species invasions. To help address this threat the EPA and USGS have developed a hierarchical database (PCEIS) that synthesizes existing biogeographic, life history, and invasion history information for estuarine and near-coastal species at a global scale. The PCEIS database is a powerful bioinformatics tool that serves multiple purposes. For example, it can be used to synthesize invasive species distributions and invasion patterns in the North Pacific. Additionally, it can also be used to identify which native North Pacific species may be susceptible to various climate change scenarios given life history and preferred habitat characteristics. Using this database, we have produced an Atlas of 630 marine and estuarine nonindigenous invertebrates, vertebrates, and submerged aquatic plants in the North Pacific. The Atlas has a two-page profile for each species containing a map of all known global locations by ecoregion as defined by the Marine Ecosystem of the World biogeographic schema. NIS standing at each location is classified by invasion status (native, introduced, invading, etc.).
New River Estuary, NC. This study incorporates monthly measurements of sediment deposition with measurements of deposition and other data collected over several inundation events to develop a site specific understanding of sediment delivery and depositional processes on the marsh surface. Sediment tiles affixed to the marsh surface were used to measure monthly accumulation rates and petri dish style filter traps were used to measure accumulation over single inundation events representing different tidal phases. The single inundation sampling events also included concurrent measurements of surface and overwash hydrodynamics (flow and water level), suspended solid (TSS) concentration, and vegetation parameters. Topographic elevation data, creek morphology, sediment grain size, and organic fraction were also incorporated into the data analysis. Preliminary results indicate that TSS concentrations in the tidal creek channel range from 2 to 28 mg L⁻¹. Surface sediment deposition patterns suggest increased deposition near the tidal creek channel and in areas with lower surface elevations (4.2 mg cm⁻² - 5.2 mg cm⁻²) and lower deposition in the marsh interior (0.1 mg cm⁻²). Additionally, the highest deposition rates (25.7 mg cm⁻²) coincided with the passing of a tropical storm system in September, 2010. The results presented here will be used as precursory data for future studies on assessing the effect of meteorological forcing events and astronomical tidal ranges on sediment availability and transport, and spatial sedimentation patterns at the local scale.

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ECOLOGICAL IMPACTS OF CLIMATE-RELATED ICHTHYOFaUNAL SHIFTS ON THE NORTHERN GULF OF MEXICO RED SNAPPER POPULATION: AN EXPERIMENTAL APPROACH

Large and apparently unprecedented increases in the abundance of juvenile gray snapper (Lutjanus griseus), lane snapper (L. synagris), groupers and many other tropical species within northern Gulf of Mexico (nGOM) seagrass meadows have been recently documented. Although previously occurring infrequently within the nGOM, their increased abundance is coincident with regional warming trends, and may result in higher numbers of offshore, reef dwelling adults of these species. Given the past stability in the relative abundance of commercially important snappers and groupers in the nGOM, increases in tropically associated coinmanials could result in increased competitive interactions with abundant temperate nGOM reef fishes, such as juvenile red snapper (L. campechanus), and bring about permanent shifts in the species composition of offshore fish assemblages. Using both additive and subtractive experimental designs, we are documenting the intensity of these interactions in experimental mesocosms to assess the degree of competitive overlap between increasingly abundant tropical snapper species and juvenile red snapper. Parameters including condition indices, prey consumption rates, schooling intensity, habitat affinity, and behavioral interactions in the presence and absence of other snapper species are being monitored and quantified using video and still photography. Through observation of the interactions between tropical and temperate reef fishes in experimental mesocosms, and concurrent continued monitoring of the offshore fish community, we anticipate documenting the ecological consequences of lower latitude invaders upon the commercially important reef species of the nGOM and assessing the impacts of warming-related species shifts within reef-associated fish assemblages.

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A SYNTHESIS OF LINKED PALEOECOLOGICAL AND REGRESSION MODEL EVALUATIONS TO SIMULATE EVERGLADES HYDROLOGY AND FLORIDA BAY SALINITY RESPONSE FOR CERP RESTORATION PERFORMANCE MEASURES

A primary goal of the Comprehensive Everglades Restoration Plan (CERP) is restoration of freshwater patterns delivered to Florida Bay resulting in a restored salinity regime. Performance measures (PM) developed by RECOVER (Restoration Coordination & Evaluation) are based on a linked method using paleoecologic characterizations and multiple linear regression models to simulate upstream freshwater flow and stage from paleo-based estimates of salinity (Marshall et al, 2009). In recent work, the system of models was improved to include the effects of sea level rise and non-linear relationships over the 36-year period of simulation. The updated procedure was applied using cores from Whipple Basin, Rankin Lake, Russell Bank, Little Madera Bay, and Crocodile Point. The model outputs were synthesized using Optimal Linear Combines into a combined estimate of stage and flow needed to produce the synthesized paleo-based salinity. When the results are interpreted, the combined paleo-based flows in Shark River and Taylor Sloughs are about 2.5-3 times and 3.5-4 times the average existing flow, respectively. The paleo-based increase in Shark River and Taylor Sloughs water levels are about 0.25m and about 0.31m, respectively. Paleo-based salinity values in Florida Bay are about 10 salinity units less than observed values in nearshore areas and about 5 salinity units less in outer regions. The freshwater flow currently discharged from the managed hydrologic system into tidal waters was found to be sufficient to make-up the estimated freshwater deficit. This newly synthesized picture of pre-drainage hydrology is being implemented in PMs for CERP.
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PROJECTS OF CETACEAN LOGIC FOUNDATION ARE EXAMPLES OF MODELING AND ANALYSIS TOOLS FOR LINKING WATERSHED FRESHWATER AND NUTRIENT LOADS AND ESTUARINE AND COASTAL HYDROLOGY, SALINITY, AND WATER QUALITY FOR THE EVALUATION OF FLORIDA COASTAL WATERS

Cetacean Logic Foundation, Inc., located in Volusia County, has completed a number of estuarine and coastal research projects in central and south Florida that serve as examples for community leaders of available estuarine research tools that utilize existing data. This poster will highlight projects completed in the past 15 years that have studied estuarine salinity and water quality including the link to watershed land use, cover, and hydrology. Projects presented may include work completed in coastal areas of all east Florida counties from the northern State line to Key West. Volusia County projects include watershed nutrient loading studies for Spruce Creek and Rose Bay, Nova Canal, and Mosquito Lagoon, and a numeric modeling circulation study for Rose Bay that showed the benefit of a wider causeway opening. A water quality characterization study was completed for the Indian River Lagoon system that estimated watershed nutrient loads. Work in south Florida includes the use of statistical models to link watershed hydrology and salinity in Florida Bay and southwest Gulf coast areas of Everglades National Park (ENP) for Comprehensive Everglades Restoration Plan research. Mass-balance salinity models, both simple and dynamic, have been developed for studies of the impact of Everglades drainage projects on Biscayne Bay and Florida Bay, and these models have subsequently been converted to use as nutrient modeling tools to evaluate the effects of nitrogen and phosphorous loadings. Paleoecological characteristics of sediments from the USGS have been coupled with CLF statistical models to simulate the pre-drainage salinity regime in the estuaries of ENP. These projects serve as an example of the use of simple models and existing data that are applicable to many other coastal systems in Florida. The presenter is also a member of the Florida Department of Environmental Protection Numeric Nutrient Criteria Marine Technical Advisory Committee.

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LESSONS LEARNED: A LOOK AT THE CHALLENGES OF MAINTAINING A REAL-TIME WATER QUALITY SENSOR NETWORK

In 2007, the Sanibel Captiva Conservation Foundation (SCCF) began the deployment of the River, Estuary, Coastal, Observing, Network (RECON). RECON is a real-time water quality monitoring network with eight nodes covering approximately 285 km2. RECON provides hourly readings of 10 water quality parameters to a dedicated website (www.recon.sccf.org). Public access to the data is available in graphical format on the website via Atlanticic’s LOBOViz data visualization software. Originally developed at the Monterey Bay Aquarium Research Institute (MBARI), SCCF purchased the first commercially available Land/Ocean Biogeochemical Observatory (LOBO) units in 2007 from Satlantic. While other real-time monitoring networks exist, the large geographic extent of RECON and the relatively small dedicated staff and budget from SCCF make it very unique. Although LOBO was extensively tested by MBARI in the Eklhorn Slough, the warm sub-tropical environment of Southwest Florida presented new operational challenges and many lessons have been learned over the past four years. Originally designed as busy, it was necessary to develop a method of attaching the LOBO to a fixed structure, due to concerns regarding high boat traffic in the area. This system had to be easily operated by a two man crew out of a small boat. Obtaining permission from the United States Coast Guard to attach the LOBOs to channel markers allowed us to avoid the large cost associated with the installation of pilings; however, it presented an unforeseen drawback, as a couple of the channel markers were prone to being knocked over by wayward boats. The warm water temperatures created many problems related to bio-fouling that had to be addressed concerning both maintaining quality data and preventing physical damage to the sensors. In addition to in house modification, we worked with Satlantic and Wet Labs to develop overall improvements to the system. Lessons learned here can be applied to other observing systems.

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LABYRINTHULA PATHOGENICITY AND SEAGRASS SUSCEPTIBILITY TO INFECTION: A MULTI-APPROACHED PROAGED

In 2003, significant declines in Zostera marina beds were reported in the San Juan Archipelago, WA. Although the declines have continued, their cause is still unclear. Work done in the 1980s by Muehlstein et al. indicated that diseased eelgrass was present at sites in the San Juan Archipelago and that the wasting disease pathogen, Labyrinthula zosterae, could be isolated from plants at these sites. However, the possibility that current loss is the result of disease events has not been thoroughly tested. In this study, our goal was to obtain a direct, semi-quantitative measure of pathogen loading by Labyrinthula zosterae in eelgrass beds considered to be either declining and at-risk, or stable and healthy, within the San Juan Archipelago. Sites with known varying Z. marina genetic diversity and population stability were chosen for investigation. Three approaches were used to characterize the pathogenicity of Labyrinthula isolated from seagrass collected at these sites: colony and cell morphology measurements, infection potential assessments, and a molecular barcode approach. Based on results of these analyses, and the morphotyping of all isolates, we provide a relative measure of L. zosterae loading among the beds studied. We also offer advice on the quickest method for identifying L. zosterae isolated from Z. marina beds.

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TOP-DOWN AND BOTTOM-UP REGULATIONS IN A HIGH NUTRIENT-HIGH HERBIVORY MACROTIDAL COASTAL ECOSYSTEM IN NORTHERN PATAGONIA, ARGENTINA

One of the main assumptions in coastal eutrophication studies is that eutrophication causes a significant shift in benthic communities along with great losses of both species and functional diversity. In this study we use San Antonio Bay (40° 7’ S and 64° 9’ W, Río Negro, Argentina) to understand the relative importance of bottom-up and top-down controls on macroalgal blooms in a macrotidal system with high nutrient supply and high consumer abundance. Our results show that nutrients, P, and O2 concentrations were higher during low tide. A field experiment showed that the biomass accumulation rate of Ulva lactuca ranged between 6 and 12% d-1 and was reduced by herbivory by 60%. The biomass accumulation rate did not differ in thalli with different initial nutrient pools. There was a negative relationship between the percentage of algal consumed and the N content in algal tissue suggesting compensatory feeding by herbivores. In a second experiment, herbivory reduced the biomass accumulation rate of U. lactuca when PO4-3 concentration was added, but not when NO3- was added. In the absence of herbivory, the addition of nutrients did not increase U. lactuca biomass accumulation rate. Under these conditions, top-down and bottom-up forces interact in the regulation of macroalgal proliferation. Although the ultimate mechanism operating is unknown, the high herbivory pressure and the response to NO3 addition only when herbivores were present are evidence that both regulation forces act conjointly. Altogether, our results suggest that nutrients remain high enough for adequate time intervals to be amased by macroalgae and support blooms. Large water exchange during tides, however, can diminish the potential negative effects of macroalgal accumulation (oxygen depletion, high ammonium concentrations) on herbivores so that herbivores can have a large impact on macroalgae.

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EFFECTS OF SALT WATER INTRUSION ON DENTRIFICATION AND GREENHOUSE GAS EMISSIONS IN TIDAL FRESHWATER FLOODPLAIN FORESTS OF SOUTHEAST GEORGIA, USA

We measured ambient and potential denitrification in tidal freshwater floodplain forests (tidal forests) of the Altamaha, Satilla, and Ogeechee rivers in southeast Georgia to characterize nitrogen removal from these understudied systems. Further, we examined the effects of simulated salt water and increased greenhouse gases (CO2 and CH4) by incubating soils exposed to 0%, 2%, and 5% water. Ambient
suggesting that denitrification is NO₃⁻. Potential denitrification was two to eight times greater than ambient denitrification, however, low levels of salt water intrusion generally increased CO₂ production while simultaneously suppressing CH₄ production, altering the overall balance of greenhouse gas production from tidal forests.

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WATER QUALITY, PHYTOPLANKTON BIOMASS, AND PRIMARY PRODUCTIVITY IN THE CALOOSAHATCHEE ESTUARY, FLORIDA

Urban and agricultural development in and around the Caloosahatchee River and Estuary on the southwest coast of Florida has altered the flow and quality of water in the system since the late-1800s. Recent algal blooms have brought attention to nutrient and processes affecting production and biomass accumulation there. The primary objectives of this project were to (1) measure phytoplankton productivity in order to test a previously developed empirical model that is based on simple measures of phytoplankton biomass and light availability in the photic zone, (2) define the abundance and composition of the phytoplankton community in order to identify patterns of succession, and (3) assess changes in water quality for its direct and indirect effect on the phytoplankton community, primary production, and the model relationship. Experiments and analyses were conducted using integrated water samples collected monthly between February 2009 and February 2010 at four sites (one each in the upper estuary, middle estuary, lower estuary, and San Carlos Bay). Primary production rates, in terms of oxygen evolution, were measured using simulated in situ light/dark bottle incubations in a flow-through raceway. Gross primary productivity (GPP) rates ranged from 0.09 to 3.12 μg C m⁻² d⁻¹ with the overall annual mean estimated at 331 μg C m⁻² d⁻¹. When the estimates from all four sites were pooled there was a strong linear relationship between daily GPP and the model predictor (r² = 0.84, p<0.001). The model tended to overestimate productivity during the “dry” period when dinoflagellates were dominate and underestimate productivity during the “wet” period when diatoms were dominate. These deviations in the model were examined as indicators of secondary controls on phytoplankton production in this estuary.

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ABBIOTIC AND BIOTIC DRIVERS OF INTRASPECIFIC VARIABILITY IN BEHAVIOR SHAPE THE ECOLOGICAL ROLES OF JUVENILE BULL SHARKS

Juvenile bull sharks inhabit coastal estuaries worldwide, and are often one of the largest bodied predators within their respective systems, but their ecological roles within these systems, and factors that might shape them, remain largely unknown. Such an understanding is important with ongoing changes in population sizes of sharks and modification of abiotic conditions within coastal estuaries. We used seasonal and interannual variation in environmental conditions and long-term sampling of bull shark populations in the Shark River Estuary of Everglades National Park, to assess how anthropogenic changes might alter the role sharks play in this ecosystem. We used passive acoustic telemetry to quantify shark movement patterns and stable isotope analysis to gain insights into shark foraging ecology. In general, our results suggest that juvenile bull sharks remained within the confines of the estuary (at least 10 km from the mouth) for their first three years, and began to use more coastal habitats and incorporate marine taxa into their diet after this time. However, there was considerable intraspecific variability within the population; notably some individuals used both upstream and coastal waters relatively early in their residence, and specialized on marine prey, suggesting they may serve as a mobile link between two distinct trophic systems (marine and estuarine). Predation risk appears to be a strong driver of movements and diets of juvenile bull sharks, but environmental conditions mediate shark movements and trophic interactions. Together, our results suggests that changes in population sizes of large coastal sharks as well as anthropogenic alterations of abiotic conditions within the system (e.g. sea level rise, changes in hydrology associated with Everglades restoration) may affect the behavior, and subsequently the ecological role, of juvenile bull sharks in the ecosystem.

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RESPONSE OF THE JAMES RIVER ESTUARY’S LONGITUDINAL DENSITY GRADIENT TO RIVER INPUT

Year-long time series of daily river discharge, hourly salinity values, hourly wind velocities and hourly water level values were used to characterize the response of the longitudinal density gradient in the James River estuary to river discharge. Salinity data were compiled from upstream and downstream ends of the estuary. Extended periods of zero salinity at the upstream end, during some periods of the year, obscured the calculations of density gradient. Overall, the values of density gradient throughout the year oscillated between 6.8 x 10⁻⁸ kg/m³ and 3.3 x 10⁻⁴ kg/m³, with the largest values appearing in the spring months of March through May. Coherence analyses indicated that variations in river discharge were best correlated (coherence amplitude > 0.6) with water level and salinity variations at periods of approximately 2 days. Wind variations were also correlated with water level but there was no clear relationship between wind velocity and salinity 2-day variations in the James River. Density gradient oscillations were also well correlated with water level and river discharge at periods of 2 days. Because of the dominance of 2-day periodicities in the estuary, it is postulated that salinity variations are tied to forcing from the boundaries at the adjacent Chesapeake Bay and from river discharge. Such forcing at the boundaries in turn should be driven by atmospheric forcing with 2-day variability.

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TOWARDS A SOUTH AFRICAN ESTUARINE MANAGEMENT PROTOCOL

South Africa has more than 250 functional estuaries that are distributed throughout a ± 3200 km coastline. Estuarine management is dynamic and complex in that decisions are continuously made based on the changing natural, social, political and economic context including the outcomes of the past decisions. South Africa is not immune to this, as management of certain aspects of estuarine management, for example, water quality and quantity, land use and resource management falls under legislation and the mandates also fall under different government departments at National, Provincial and Local levels. The fragmented nature of the environmental legislation and overlapping mandates is providing a huge threat to the effective management of estuaries as there is no integrated approach in dealing with different aspects estuary management. The President of the Republic of South Africa proclaimed the National Environmental Management: Integrated Coastal Management Act, 2008 (Act No. 24 of 2008) ("the ICM Act") in 2009. The ICM Act among other things requires that estuaries of the Republic be managed in a co-ordinated and efficient manner and in accordance with the national estuarine management protocol ("the Protocol"). The Protocol will among other matters give detailed direction on who should be responsible for the different areas of estuary management, set procedures and standards for the drawing up of individual estuary management plans, and their implementation. This paper examines the process that lead to the development of the protocol and highlights key strategic objectives and management strategies that need to be achieved in order to have an efficient, co-ordinated and hence integrated approach to the management of estuaries in South Africa.

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CHANGES IN COASTAL FISH COMMUNITIES IN THE NORTHERN BALTIC SEA - COMMUNITY LEVEL RESPONSES TO FISHING PRESSURE AND EUTROPHICATION

Fish populations in three coastal areas in the northern Baltic Sea were monitored by annual gillnet fishing in 1995–2009. The test-fishing results were related to fishing pressure and water quality in the study sites. During the study period all three coastal fish communities shifted from being dominated by pikeperch (Sander lucioperca) and perch (Perca fluviatilis) towards a dominance of cyprinids. Especially the proportion of large individuals decreased, decreasing the overall size of fish in the communities. In one of the study sites also the fourhorned sculpin (Troglostichus quadricornis) increased drastically. The study site with the most profound change in the coastal fish community was also the most eutrophic one, and the one with the highest fishing pressure on pikeperch. A clear shift from communities dominated by predatory fish to communities dominated by secondary consumer fish was observed in all study sites. These changes most likely cause overall changes in the food webs and the whole aquatic ecosystems. We conclude that the observed profound community level changes in the coastal fish communities were due to both high fishing pressure and increased eutrophication in the study sites. Our results give additional support to the need of fisheries management based on effects of both fisheries and environmental status on fish communities.
ENDOCRINE DISRUPTING COMPOUNDS AND THEIR IMPLICATIONS FOR THE HORSESHOE CRAB POPULATIONS OF DELAWARE BAY AND DELAWARE’S INLAND BAYS

The American horseshoe crab, Limulus polyphemus, is one of several horseshoe crab species, but the only one found along the coast in North America. With a range from northern Maine to the Yucatan Peninsula in Mexico, this species has its highest spawning densities in Delaware Bay and is of great importance to the fishing, biomedical and ecotourism industries. The Inland Bays are three inter-connected, lesser known bays also in Delaware. Though in close proximity to Delaware Bay, little work has been done to determine the importance of this bay as L. polyphemus spawning habitat. Over a three year period, volunteers performed a spawning census of six sites within the Inland Bays. We found that average spawning densities of horseshoe crabs for this estuary (2.4 individuals/m²) are statistically comparable to those found in Delaware Bay (3.5 individuals/m²), implying that conservation of the Inland Bays population is important. Because horseshoe crabs spend the first four weeks to a few months of life buried in coastal beach sediments, they are susceptible to endocrine disrupting compound (EDC) exposure from sources such as runoff and groundwater. EDCs, by definition, alter normal hormone function in an organism. Although little is known about which EDCs larval horseshoe crabs are exposed to and what impacts such compounds have on larval development, studies in our lab have shown high concentrations of methoprene can inhibit development of late-stage larvae. We took a novel approach to examine these unknowns by modifying and implementing a pre-existing gas chromatography mass spectrometry method to identify which EDCs horseshoe crabs accumulate while developing in beach sediments. Eggs, embryos and larvae were collected from a total of 6 sites from within the Delaware and Inland Bays. These samples are currently being examined for accumulation of pesticides, surfactants, antimicrobials, as well as natural and synthetic estrogen.

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APPLYING ECOLOGICAL RESILIENCE THEORY: MODELLING AND TESTING THE FEEDBACK LOOPS TO PREDICT SHIFTS IN SEAGRASS ECOSYSTEMS

Theoretically, the resilience of a system to major and potentially irreversible phase shifts is supported by feedback loops that promote self organisation and resistance to small disturbances. However, understanding of the stresses driving ecosystem shifts has largely been gathered after the undesirable shifts in state have occurred. The challenge for ecologists, therefore, is to change from hindsight driven studies to a combination of predictive modelling and empirical testing to enable forecasting of sudden shifts in ecosystem state. We developed a Bayesian Network Model to assess the importance of feedback loops in seagrass meadows, and to test the effects of various management scenarios, on the persistence of seagrass at meadows experiencing different combinations and levels of stresses. The model showed that managing seagrass systems to enhance resilience to disturbance requires an understanding of the interaction between the strength of regulatory feedback loops and seagrass persistence. The output of the model was then used to select the key processes that make up the regulatory feedback loops and to inform the design of an experiment focussed on measuring the relationship between the feedback loops, changing environmental conditions and the subsequent effects on seagrass biomass in Moreton Bay, Australia. We measured processes from three feedback loops, the uptake of nutrients from the water column, the resuspension of sediments and grazing rates on algae following a large flood in January 2011. Immediately following the flood, grazing rates and sediment resuspension levels were higher at locations inside the flood plume, providing empirical evidence that regulatory feedback strengths vary in response to disturbance. The model output and empirical results provide information on the ability of seagrass meadows to buffer multiple stresses and will enable managers to better manage for the specific stresses that lead to sudden shifts in ecosystem state.

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OVERVIEW OF THE COASTAL AND MARINE ECOCLOGICAL CLASSIFICATION STANDARD (CMECS)

Recent developments including the explosion of interest in harnessing coastal and offshore renewable energy resources underscore the need for a national standard that provides a consistent approach for classifying marine ecosystems. For over a decade, NOAA and its partners (NatureServe, EPA, and USGS) have worked with scientists and managers from federal, state and regional agencies, academia, industry, and non-governmental organizations to address this need by developing the Coastal and Marine Ecological Classification Standard (CMECS). CMECS was developed to provide a common language to facilitate standardization of information in support of conservation and management. The standard builds on and integrates with existing classification approaches. Its domain extends from the coastal tidal splash zone to the deep ocean, including all substrate and water column features of the oceans as well as the deep waters of the Great Lakes. CMECS describes the defining features of habitats via a series of components. A comprehensive set of modifiers allows inclusion of additional information on environmental, structural, physical, chemical and biotic features. Components can be used and mapped independently or combined as needed for specific applications. CMECS is technology- and scale-neutral. Users choose the operational scale and level of detail suited for their purposes. CMECS is a dynamic content standard, allowing refinements with improvements in technology and information. CMECS underwent public and peer review in the fall and early winter of 2010-2011. It was revised in response to the suggestions received and will be submitted to the Federal Geographic Data Committee for formal endorsement by the close of 2011. This talk reviews the operational features of CMECS, highlighting revisions and additions made since the start of 2011. The talk provides a backdrop for discussions of CMECS field applications provided in subsequent papers of this session.

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ESTIMATING SYSTEM-WIDE SOURCES AND SINKS OF NITROGEN IN A SHALLOW MID-ATLANTIC ESTUARY - THE ROLE OF LIGHT AVAILABILITY

The New River Estuary (NRE), NC is a shallow, moderately eutrophied estuary surrounded by Marine Corps Base Camp Lejune and the city of Jacksonville. In many shallow coastal ecosystems, benthic microbial activity helps to regulate the export of nutrients, principally nitrogen (N), from the estuary, but is dependent on the benthic light environment. While several studies quantify the importance of allochthonous and autochthonous N sources and sinks in shallow systems, few account for how N cycling rates vary with depth (benthic light environment). The goal of this study was to: (1) determine seasonal and interannual variations in the relative importance of allochthonous and autochthonous sources of N to the NRE; (2) investigate how benthic microbial processes influence N availability supporting phytoplankton production, at the system-wide scale, by accounting for changes in N cycling rates with depth, estuarine position, and season. Sediment samples were collected seasonally at three water column depths (0.5, 1.5, and 3.0 m) in three characteristically different regions along the estuarine gradient. Sediment characteristics, benthic and pelagic metabolic rates, ammonification rates, and N fluxes were measured and scaled up from typical m2 and m3 rates to system-wide estimates. Results indicated that at shallow depths benthic N sources and N sinks (N2 generation and benthic microbial N demand) were in approximate balance, whereas at deeper depths sediments became net heterotrophic, resulting in increased NH4+ release from the benthos. The percentage of ammonified N removed by benthic N sinks ranged from approximately 25% and 50%, in the upper and middle estuary respectively, to nearly 150% in the lower estuary. Empirical modeling, predicting N release due to interannual and seasonal changes in benthic light availability, was conducted showing the importance of maintaining light quantity in shallow coastal ecosystems.

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“MOTHER’S” BEACHES AND THEIR WATER QUALITY ISSUES: INNER CABELRO BEACH

“Mother’s”, or “Baby”, beaches are low energy recreational areas where families, for example, can enjoy the beach with a small child and not have to worry about large waves characteristic of open coast beaches. These beaches are often situated in sheltered areas of harbors - essentially artificial estuaries - and provide an important and much valued characteristic of open coast beaches. These beaches are often situated in sheltered areas of example, can enjoy the beach with a small child and not have to worry about large waves

NUMERICAL MODELING OF MOBILE BAY

A numerical model was developed for the Mobile Bay system to investigate the impacts associated with certain system alterations. The Adaptive Hydraulics (AdH) Code was used to validate the numerical model for hydrodynamic, salinity, and sediment behavior. Due to the physics based nature of AdH, the validated model could be altered to represent the plan conditions (removal the Mobile Bay Causeway) and provide an indication of the behavior of the resulting altered system. Model simulations were analyzed to determine the impacts of the system alteration on the hydrodynamic conditions, salinity intrusion, and sedimentation behavior. In addition to these existing water level simulations, sea level rise simulations were performed to determine the impacts of the plan configuration in conjunction with future sea level conditions. This included additional comparisons of the simulations patterns, salinity intrusion, and sedimentation behavior along with inundation comparisons for the base and plan configurations for multiple sea level values. Comparisons are also included to compare the flow distribution between the different Mobile River Tributaries to provide an indication of the future flow separation due to the altered system and due to sea level rise.

EFFECTS OF OIL ON THE RATE AND TRAJECTORY OF LOUISIANA MARSH SHORELINE EROSION

Oil can have long-term detrimental effects on marsh plants above- and below ground. However, there is little data available that quantifies the accelerated erosion that oil may cause to marshes and the trajectory of change. We collected data on soil strength, shoreline erosion, and soil decomposition at 30 closely spaced oiled and non-oiled sites in Bay Batiste, Louisiana. These sites were sampled bi-monthly since November 2010 and compared to data from another 80 sites sampled in May and September 2010/2011. All oiled sites in Bay Batiste were contaminated with Macondo 252 oil (oil from the BP oil spill 20 April – 15 July 2010). Preliminary results suggest that the oil is weakening the soil and causing an accelerated rate of shoreline erosion. There is no “threshold” effect where soil parameters change dramatically with a relatively small increase in oil concentration in the soil. We will also discuss separating the influence of the background erosion rate occurring before the spill from the increased erosion due to the marsh oiling.

REFINEMENTS TO COMPREHENSIVE HYDROBIOLOGICAL MONITORING PROGRAM AFTER TWELVE YEARS OF MONITORING FOR ESTUARINE IMPACTS

Tampa Bay Water is a regional drinking water supply authority created in 1998 by inter-local agreement among six municipal governments on Florida’s Gulf of Mexico coast. Regional water supply sources include groundwater wellfields, surface water withdrawals, seawater desalination, and a large off-stream storage reservoir. Water Use Permits issued in 1999 by the Southwest Florida Water Management District for two major surface water withdrawal projects, the Alafia River and Tampa Bypass Canal/Hillsborough River, required the implementation of a comprehensive hydrobiological monitoring program (HBBM). HBBM objectives are to ensure that permitted freshwater withdrawals do not result in adverse impacts to estuarine water quality, vegetation, plankton, fish, recreational use or aesthetics, or significantly alter salinity distributions. HBBM reporting units include three estuarine tributaries and two areas of eastern Tampa Bay; monitoring elements include hydrology/water quality, biota, and habitat/vegetation. Participants include the University of South Florida, Florida Fish and Wildlife Research Institute, state and local agencies, and other stakeholders. HBBM design included identification of critical indicators with direct or indirect relationships to changes in freshwater inflows, programmatic criteria for determining unacceptable impacts, and a process for appropriate management responses. HBBM field sampling was initiated in April 2000. Since that time, several modifications have been made with stakeholder consensus based on monitoring results. A comprehensive HBBM review has been initiated recently to assess future program refinements based on monitoring objectives and findings to-date. This poster presents an overview of monitoring approaches and results, and recommendations for cost-effective monitoring to detect significant changes in freshwater flows due to withdrawals for public drinking water supply.

PROJECTED EFFECT OF EVERGLADES RESTORATION ON FLORIDA BAY SEagrASS COMMUNITIES

A goal of Everglades restoration is increased freshwater delivery to Florida Bay and modification of the timing and distribution of water inputs to better mimic natural hydrology. By coupling upland hydrologic models, multiple linear regression (MLR) salinity models, and a dynamic seagrass community model, the effect of Everglades restoration on the seagrass community of Florida Bay was examined and potential restoration targets were evaluated. Freshwater flows and levels were simulated using the South Florida Water Management Model (SFWM) under four alternatives: full implementation of the Comprehensive Everglades Restoration Plan (CERP), partial CERP implementation (“Band1”), existing condition without restoration, and future without restoration. Everglades water levels were converted to point salinity values using MLR models, which were also used to create a scenario of historic salinity conditions based on paleoecological data. The salinities were input to the dynamic seagrass community model, SEACOM. The biomass of three species, Thalassia testudinum, Halodule wrightii, and Ruppia maritima, were simulated as response variables. A transect of four species was also simulated to examine the range of responses. The sites consisted of an upstream coastal pond (with salinity range 0-40, mean 6 psu), a near-shore embayment (0-39, mean 13 psu), a northeastern Florida Bay site (5-38, mean 20 psu) and a high salinity reference site in central Florida Bay (21-30, mean 34 psu). The partial restoration scenario reduced the excessively high salinity peaks at all sites. Reduction of extreme salinity values is considered...
In a recent study, the green mussel, Perna viridis, is a recent invasive species to the coastal waters of the Gulf of Mexico. With increasing loss of seagrass beds worldwide due mainly to anthropogenic impacts, it has become important to document and understand seagrass growth under natural, yet highly variable environmental conditions. In this study, we examine morphological and growth characteristics of the seagrass Thalassia testudinum in three naturally occurring meadows from regions of the Gulf of Mexico that differ largely in underwater light penetration, temperature, and salinity: Long Key, FL; Perdido, FL; and Corpus Christi, TX. The Florida Keys are distinguished as having significantly greater water column light availability (p = 0.012; R² = 0.29), significantly higher average temperatures annually (p = 0.002; R² = 0.32), and greater salinity stability compared to Corpus Christi, TX and Perdido, FL. Shoots in Perdido, FL have significantly less photosynthetic area than shoots sampled in both Corpus Christi and in Long Key (p = 0.001; R² = 0.36). These characteristics were driven by significant differences in both shoot blade length (p < 0.001) and width (p < 0.001). The green mussel, Perna viridis, is a recent invasive species to the coastal waters of the Gulf of Mexico. Depressed structure and growth in Perdido in relation to the other two regions is likely due to reduced light availability and widely oscillating salinity. These results also indicate that these measurements can be used in conjunction with recorded environmental data to estimate population health in other regions with similar abiotic conditions.

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 following seagrass recovery in shallow coastal ecosystems. We have followed the recovery trends of replicate large (0.5 – 1.0 acre) plots ranging in age from 1 – 10 years. Parameters monitored annually include eelgrass shoot density and biomass, allocation to above- and belowground biomass, canopy height, productivity, and tissue C:N concentrations, sediment organic, carbon and nitrogen content, porosity, grain size, exchangeable ammonium, and benthic chlorophyll. The change over time in seagrass aerial productivity and carbon/nutrient sequestration is driven by an increase in shoot density, with the greatest rate of change observed 4 years after seeding. Sediment parameters also showed an initial 4-year lag period before differences were observed from initial conditions. Survivorship along a depth gradient indicates that 1.6m mean sea level is the maximum depth limit for seagrass in regions where restoration has occurred. This depth limit matches the tipping point for seagrass survival predicted for this system under current conditions from a hydrodynamic-plant growth model that includes vegetation feedbacks on sediment suspension. Future changes in environmental factors related to climate and land-use change (light, temperature, nutrients, storm disturbance) will alter the maximum depth limit and aerial distribution of seagrass in predictable ways.

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MANGROVE VULNERABILITY TO SEA-LEVEL RISE DIFFERS AMONG SEDIMENTARY SETTINGS

Persistence of intertidal wetlands is dependent upon maintenance of soil elevations relative to sea-level rise (SLR). Soil surface movement is driven primarily by a balance among mineral sedimentation, organic matter accumulation, and shallow and deep subsidence. Predicting how mangrove forests may respond to future SLR along tropical coastlines requires a better understanding of the mechanisms driving the change across a broad range of geomorphic settings. We examined factors influencing elevation change in different sedimentary settings (mineneric to biogenic) to assess relative vulnerability of mangrove forests to submergence. Both published and unpublished data were used to examine controls on soil elevations. Contrary to expectations, mineneric systems with high sedimentation rates were not better buffered against SLR. For example, Pacific high islands in Micronesia with mineral accretion rates of 9 to 13 mm yr⁻¹ were either losing elevation or only gaining slightly (~2.5 to 0.2 mm yr⁻¹), due to rapid subsidence (~8 mm yr⁻¹). In contrast, biogenic systems, dependent upon autochthonous processes, exhibited better overall resilience to relative SLR despite low accretion rates (~2 mm yr⁻¹). Oceanic islands in Belize, for example, showed subsurface expansion (due to root matter accumulation) along shorelines and elevation gains up to 3.7 mm yr⁻¹, which closely tracked changes in global mean sea level. Overall, mineneric sites showed an elevation deficit of 2 mm yr⁻¹ compared to biogenic sites, with no deficit or a surplus. However, neither biogenic or mineneric mangrove systems may survive a catastrophic rise in sea level, which exceeds their respective capacities to build vertically.

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EFFECTS OF LARGE SCALE DISTURBANCE ON COASTAL INTERTIDAL SEAGRASS MEADOWS OF NE QUEENSLAND, NORTH-EASTERN AUSTRALIA

Seagrass meadows change as a result of both natural and anthropogenic impacts, some being highly dynamic as a result. Seagrass meadows of the Great Barrier Reef are characterised by high disturbance regimes at least in part due to the prevalence of seagrasses in coastal habitats. These habitats are dominated by the presence of readily re-suspended fine sediments, grazing by dugong and green turtle and where the influence of cyclones and large flood events are most acutely experienced. In March 2006, severe Tropical Cyclone Larry crossed the tropical north Queensland coast. Although quite small in size, TC Larry caused extensive damage along approximately 100km of coastline. Coastal intertidal seagrass meadows monitored along the tropical north Queensland coast over a decade as part of the long-term Seagrass-Watch monitoring program provided an opportunity to study the level of disturbance and rate of recovery following this event. In locations to the north and south, before and after the cyclone, seagrass distribution, abundance, community structure and reproductive status was assessed within the high impact zone. The findings indicated that the level of impact and rate of recovery are highly influenced by the level of physical disturbance and the availability of seed reserves. In the high impact zone, disturbance was greatest and meadow recovery was slow due to absence of a seed reserve and reliance on vegetative reproduction before meadow loss. In contrast, in adjacent regions recovery was relatively rapid due to the presence of large seed reserves. This demonstrated that recovery processes are key disturbance coping mechanisms and that meadow resilience may be linked to the presence of propagule availability to assist with the recovery process after larger scale disturbances. We will discuss the adaptability of different seagrass habitats to different disturbance regimes and implications regarding future climate change predictions.

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INVESTIGATING THE CAUSE AND ECOLOGICAL IMPACTS OF REDUCED PRIMARY PRODUCTION IN MASSACHUSETTS BAY, MA, USA

In September of 2000, the Boston Harbor sewage outfall was relocated 15 km offshore in Massachusetts Bay to decrease pollution in the Harbor. Since 1992, the Massachusetts Water Resource Authority has conducted long term monitoring to assess the ecological impacts at both the Harbor and the new outfall site. Two years after the outfall relocation, primary production decreased dramatically in the Harbor due in part to the decrease in nutrient loading from the old outfall location. However, the new outfall site was also characterized by a decrease in primary production, where nutrients might have been expected to increase. In determining contributing factors to the decreased primary production, wind speeds and directions as well as North Atlantic Oscillation (NAO) indices were compared to respective years’ primary production. Phase shifts in the NAO have been noted to decrease Atlantic westerly wind patterns and associated winds, thus controlling extratropical variables influencing primary production, such as water column mixing. Over the last 9 years, decreased annual wind and gust speeds corresponded to decreased annual primary production. Slackening of winds enhanced water column stratification, inhibiting upwelling of nutrients to the photic zone for phytoplankton growth. We compared wind strengths and direction to stratification intensity and upwelling behavior. The decrease in primary production may have caused a decrease in benthic-pelagic coupling and interactions with other trophic levels. Reduced dissolved inorganic nitrogen fluxes from the benthos might indicate reduced pelagic organic matter reaching the benthos. Zooplankton abundances have also decreased at the outfall site since 2002 and may be related to the reduced primary production patterns.

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ENVIRONMENTAL AND PHYSIOLOGICAL INFLUENCES ON δ¹³C OF ZOSTERA MARINA (EELGRASS)

Utilization of CO₂ for photosynthesis differs between seagrasses and other marine autotrophs, which is likely responsible for disparities in δ¹³C. Seagrasses obtain nearly 50% of their inorganic carbon from dissolved aqueous CO₂ (CO₂(aq)), while marine algae obtain only 20% from CO₂(aq). The carbon isotope signature in seagrass leaves can be influenced by a variety of environmental and physiological conditions including: (i) the source and concentration of inorganic carbon; (ii) water temperature altering the solubility of CO₂ in seawater; (iii) turgor boundary layers affecting diffusion of CO₂ across the leaf-water interface; (iv) internal recycling of CO₂ in the lacuna; and (v) light availability. Boundary layers have been explored very little with respect to δ¹³C in seagrasses and studying this effect may provide insight for understanding the dynamics of carbon isotope fractionation in seagrasses in leaves, and scaling them up to whole populations. This study investigated the influence of CO₂ permeability, controlled by biochemical (CO₂(aq))/j, physical (light, temperature, and diffusion boundary layers), and physiological (photosynthesis) mechanisms, on photosynthesis and δ¹³C composition of Zostera marina L. (eelgrass) from the Chesapeake Bay using an integrative approach between theoretical calculations, laboratory measurements and in situ measurements for light, [CO₂], and environmental conditions. We scaled photosynthesis to Pmax providing a dimensionless value between 0 and 1 for photosynthesis (P⁺). The linear relationship between modeled productivity and measured stable isotope fractionation provided a simple calculation to model δ¹³C for Z. marina. The ability to accurately model productivity and δ¹³C of a seagrass population suggests a comprehensive understanding of the influence of light, carbon acquisition and environmental conditions on photosynthesis.

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APPLICATION OF SUNTANS TO OPTIMIZE RESTORATION EFFORTS OF CRASSOSTREA VIRGINICA WITHIN CANAVERAL NATIONAL SEASHORE, FLORIDA

Estuaries provide a vital habitat, and the eastern oyster, Crassostrea virginica, is paramount towards continually making these ecosystems ecologically and economically viable. In addition, the reef structures created by oysters provide homes for other organisms, thus further enhancing the oyster’s value. However, the eastern oysters in central Florida are in severe jeopardy; “on the ground” efforts are underway towards restoring these reefs. To geographically target future restoration efforts and promote oyster larval recruitment, a scientifically-based approach will be implemented. The SUNTANS hydrodynamic model will be applied to simulate the tidal and wind-driven flows within the a portion of Canaveral National Seashore. Once calibrated, this model will be seeded numerically at healthy reefs with active (i.e., mobile) particles to represent oyster larvae, the building blocks of these reefs. Their paths will be tracked to determine areas of convergence and initial recruitment. Once fully realized, the hydrodynamic and particle tracking models will be a useful tool to guide restoration efforts and predict the impacts sea level rise will have on the larva’s transport and dispersal.

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TRIAL OF NEW PCO2 SENSOR IN MULTIPARAMETER WATER QUALITY MONITORING ASSOCIATED WITH ZOSTERA MARINA BEDS IN LITTLE PLEASANT BAY, CAPE COD NATIONAL SEASHORE

The Cape Cod National Seashore, with the help of the U.S. Geologic Survey, has been monitoring eelgrass in Pleasant Bay, Orleans, MA since 2003. Recent improvements in water quality due to increased tidal flushing caused by the formation of a new tidal inlet in 2007 has allowed for the expansion of eelgrass distribution and density throughout the bay. The positive effects of eelgrass on water quality in regards to water filtration, nutrient sequestration and sediment stabilization are widely recognized. However, the contribution of eelgrass to CO₂ dynamics is poorly understood. YSI, Inc recently developed an in situ sensor that measures partial pressure of CO₂ (pCO₂). In 2011, two YSI 6600V2-4 sondes
continuously measured pCO2, as well as pH, chlorophyll a, DO, temperature and conductivity for three months at two locations in Little Pleasant Bay. The sondes were placed inside and outside of eelgrass beds within the system. The addition of a pCO2 sensor to the YSI in situ sondes for continuous monitoring not only provides a powerful ecological monitoring tool that allows more complete understanding of environmental dynamics and process, but the data collected provides preliminary information on the physical and biological processes controlling CO2 dynamics in this system.

**ECO-HYDROLOGICAL ASSESSMENT OF A SHALLOW TROPICAL ECOSYSTEM IN THE WESTERN CARIBBEAN**

Bahia de la Ascension (BA), a shallow bay located in the east coast of the Yucatan Peninsula is surrounded by mangrove wetlands and a fringing reef lagoon. This study aimed to examine the relative contribution of groundwater discharge (GD) and coastal hydrodynamics on the hydrographic variability of BA. A marked seasonal pattern of precipitation characterizes the climatology of the region. Monthly evaporation varies from 4% in October to 60% in April. The combined runoff and GD into BA showed larger fluctuations than direct rainfall and thus, have a greater potential to alter the seasonal salinity variations within the system. The spatial pattern of salinity in BA exhibits a strong horizontal SW-NW estuarine gradient. Hurricanes influence up to 36% the inter-annual precipitation variability. These meteorological processes drove substantial changes on the salinity spatial gradients within BA by altering the water residence time and the magnitude of exchange with the ocean. The semi-diurnal tide is selectively attenuated in the interior of BA, as diurnal frequencies are more readily filtered out than the semidiurnal ones. The time-averaged water motion in BA is characterized by seawater inflow through the north inlet and outflow through the south inlet. Winds enhance water flushing from the system’s interior to the main bay, particularly when acting along the main northeast-southwest axis in the bay (i.e., Trades and south-easterly winds). Thus, despite the tidal forcing controls the hydrodynamics and mixing characteristics between brackish and marine-influenced water masses in the main bay, dampening of tidal energy at the inner bay suggests that salinity at the system’s interior is mainly controlled by the freshwater supply, in turn strongly modulated by short-term processes (wind stress), low frequency-high intensity storms, and likely inter-annual scale events (e.g., ENSO), as well as land use management and water policies.

**QUANTIFICATION OF ORGANIC MATTER AND PHYSICAL-CHEMICAL CHARACTERIZATION OF MANGROVE SOIL AT HOOKER BAY, SAN ANDRES ISLAND - COLOMBIA**

The soils play an important role in the CO2 capture, a major gas in climatic channel. The goal of this study was to quantify, during the dry season, the organic carbon content of the mangrove wetland located in Hooker Bay, San Andres Island, Colombia. The changes in the concentration of organic matter through soil profile were evaluated. A structural analysis of the mangrove wetland profile was carried out in order to relate it to the physical-chemical parameters (pH, salinity and dissolved oxygen) and to the organic matter. The mangrove soil studied contains an average of 173.96 kg C/m2 in the first top 100cm of depth. There were neither significant differences among the depths evaluated (p < 0.05) nor correlations between the organic matter in the physical-chemical parameters. The mangrove wetland studied has a low structural development. Three species with decreasing IVI (Index Value) were found: Rhizophora mangle > Avicennia germinans > Laguncularia racemosa. The mangrove soil studied has a high potential as carbon reservoir in the form of organic matter because it is one of the ecosystems that accumulates larger carbon quantities.

**THE GOOD NEWS - BAD NEWS STORY OF THE DEEPWATER HORIZON BLOWOUT FOR COASTAL MARGHES: A PRELIMINARY OVERVIEW**

The Macondo 252 oil spill resulting from the blowout of the Deepwater Horizon (DWH) drilling platform on April 20, 2010 released approximately 4.9 million barrels of crude oil into the Gulf of Mexico. Some of this oil reached coastal marshes within the Mississippi River Delta Ecosystem, which comprises almost 40% of all coastal wetlands in the 48 contiguous United States. These wetlands are of particular concern because of the suite of highly and economically valuable services they provide, not the least of which is the protection of the northern Gulf of Mexico, but also to the nation. We present an overview of the DWH event vis-à-vis coastal wetlands, and results from field and greenhouse studies to assess remediation and impacts to various components of the marsh system. Although this research is ongoing, we can make some general statements at this point in time. Although oiled marsh shorelines only represent about 5% of the Louisiana coastline, where oiling was classified as heavy, oil impacts on marsh vegetation structure were severe and evident even 8 months after the spill. Concentrations of total petroleum hydrocarbons in the soil were significantly higher with higher oiling category. Oiling significantly reduced aboveground biomass of salt marsh plants, primarily S. alterniflora and Juncus roemerianus. Areas of plant stubble were evident along many heavily oiled shorelines apparently due to plant mortality and subsequent removal by waves and tides. However, new plant shoots have emerged from surviving belowground rhizomes in some locations, especially for S. alterniflora. Greenhouse results confirm field measurements. Although oil-coated shoots were negatively impacted and became necrotic, plants survived oiling and were able to gradually recover by generating new shoots regardless of degree of oil coverage. Ultimate vegetation recovery in the field will likely be more complex and controlled by a number of physical, chemical and biotic factors including cleanup efforts.
compared to Isabella. The long term goal is to correlate community structure to changes in water chemistry over time.

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INVESTIGATING SHELLFISH CLOSURE AREAS AS POTENTIAL LARVAL SOURCES FOR NORTHERN QUAHOG POPULATIONS IN NARRAGANSETT BAY, RHODE ISLAND

The northern quahog, Mercenaria mercenaria, is a commercially important species in Narragansett Bay and is unique in that it has benefited from the anthropogenic eutrophication of the bay. Stable isotope analyses have shown that a large portion of the diet of quahogs is derived from nutrients entering the bay as sewarage. In addition, field studies indicate that quahog predation is reduced by the intermittent hypoxia that occurs in areas of the bay as the sedentary quahogs are more tolerant to low oxygen levels compared to their mobile predators which migrate out of areas experiencing hypoxic conditions. Quahogs also have a history of being managed in a spatially explicit manner due to the human-health hazards associated with the consumption of shellfish from polluted areas. The non-harvested Narragansett Bay and is unique in that it has benefited from the anthropogenic impact populations of quahogs bay-wide if there is a high degree of larval export from the formerly polluted areas. Harvesting the large reproductive biomass in these formerly polluted areas could amount of untreated sewage entering Narragansett Bay by an estimated 880 million gallons per year. Harvesting the large reproductive biomass in these formerly polluted areas could improve population of quahogs bay-wide if there is a high degree of larval export from the formerly polluted areas. Analyzing the contribution of these areas to the population of Narragansett Bay as a whole may provide insight into the effectiveness of marine protected areas (MPAs) in a fisheries management context.

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THE ALTERATION OF ESTUARINE CIRCULATION DUE TO LARGE-SCALE CONSTRUCTION: A TAMPA BAY EXAMPLE

Changes in the residual circulation and residence time of a drowned river bed estuary due to alteration of bathymetry by the dredging of shipping channels and the construction of bridges and causeways are found to vary over time. Two identical three-year simulations are performed using numerical estuarine circulation models of Tampa Bay that differ only in their bathymetry. The first bathymetry represents the present day and the second the pre-construction year 1879. Model output is divided into three distinct 30-d time periods each representing different baroclinic regimes. Changes in average tidal speeds are largest in regions near causeways and spoil islands, and are essentially time-independent. Changes in residual salinity and velocity are largest during the period of strong baroclinic circulation. Changes in residence time are largest during the period of weak baroclinic circulation.

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COMMUNICATING PROGRESS TOWARDS MARYLAND'S NUTRIENT REDUCTION GOALS ASSOCIATED WITH THE CHESAPEAKE BAY TMDL

The U.S. Environmental Protection Agency issued a Total Maximum Daily Load (TMDL) for the Chesapeake Bay on December 29, 2010 due to major portions of the Bay and its tidal tributaries failing their water quality criteria for dissolved oxygen (D.O.), water clarity and chlorophyll. All six Bay watershed States and the District of Columbia have been issued draft nutrient (N), phosphorus (P) and sediment load allocations, that if met are predicted to meet D.O. criteria in all tidal segments. The total draft nutrient allocation for the Chesapeake Bay is 187.4 million lbs N and 12.5 million lbs P. Maryland's N and P load allocations are 39.09 and 2.72 million lbs respectively. In order to reach the Maryland goal, State agencies working with local and federal agencies have committed to accelerating their restoration implementation yet there are few documented improvements in Bay water quality. Although N trends show improvements at 46 of 54 Maryland long-term non-tidal monitoring sites, there are limited improvement N trends in the Chesapeake Bay and tidal tributaries. The few improving N trends are in areas where point source reductions have been implemented. The Potomac estuary tidal fresh segment shows improving N trends and is dominated by upgrades to wastewater treatment facilities. Tidal segments on Maryland's Eastern shore show no significant N trends and are dominated by non-point sources of pollution. The challenge to scientists and the monitoring community is communicating restoration progress towards a cleaner and healthy Bay to federal, state and local agencies and managers committing billions of dollars for restoration implementation.

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THE SOUTHWEST COASTAL LOUISIANA FEASIBILITY STUDY: REGIONAL SCALE HYDROLOGIC AND SALINITY MODELING AND MANAGEMENT SCENARIO ANALYSIS FOR CHENIER PLAIN

The Chenier Plain, in Southwest Louisiana, extends from Vermillion Bay to Sabine Lake in southeast Texas. It has great economic, industrial, recreational, and ecological value. Over the years, human activities such as dredging ship channels and access canals, building roads, levees, and hydraulic structures have altered the hydrology of the Chenier Plain. These alterations have affected the fragile equilibrium of the marsh ecology. If no action is taken to restore the Chenier Plain, land loss through conversion of marsh to open water would continue. The Southwest Coastal Louisiana Feasibility Study aims at evaluating proposed restoration scenarios and ultimately submitting a comprehensive plan to protect and preserve the Chenier Plain at the regional scale. The proposed alternatives include marsh creation, terracing, shoreline protection, and freshwater introduction and salinity control structures. A regional scale hydrodynamic and salinity transport model was developed to screen and assess the proposed restoration measures. The model will also improve our understanding of the salinity patterns and salinity regimes of the region. The circulation model used here is the MIKE FLOOD software (Danish Hydraulic Institute, DHI 2008) which dynamically integrates a two-dimensional grid (MIKE 21) and a one-dimensional channel flow simulation tool (MIKE 11). The model was successfully calibrated and validated using water level and salinity data collected at monitoring stations in the channels and throughout the marsh from various sources (USACE, USGS, NOAA, OCPR, etc.). The model prediction agreed favorably with the field measurements at the daily and monthly average temporal scale. Uncertainties in the bathymetric data, open water boundary, as well as the operation schedules of water control structures prevented the model from being validated at a higher temporal frequency. Ongoing monitoring efforts are being used to minimize these uncertainties.

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PREDICTING DISTRIBUTION AND ABUNDANCE OF MARINE MACROALGAE

The distribution and abundance of plants and animals are regulated by a suite of physical and chemical factors. Understanding the importance of each factor is central for our ability to describe the potential occurrence of populations and to predict the impact of permanent or temporary changes in the environment. The aim of this study was to predict the potential occurrence and abundance of macroalgae in Fehmarnbelt from the most important regulating factors. As a part of the environmental investigations in connection with the planned fixed link between Denmark and Germany the occurrence, biomass and cover of macroalgae were studied along transects in Fehmarnbelt and the adjacent water bodies. Moreover, the occurrence of suitable hard substrate was estimated, the bathymetry described and a number of parameters describing hydrodynamics (salinity, temperature, current speed and shear stress) as well as factors describing the water quality (Secchi-depth, total N and total P) was extracted from a calibrated numerical model. The results showed that the most important parameter for the distribution of benthic macroalgae was the availability of hard substrate. This factor could alone describe 34% of the variability in cover of macroalgae. Depth, slope, light, salinity and total P explained less than 10% of the variation in cover as single factors. Suitable hard substrate, depth, shear stress, slope, current speed and Secchi-depth explained together 55% of the variation in cover of macroalgae. The model was used to predict the potential occurrence and cover of macroalgae. Biomass showed an exponential decrease with depth and there was a distinct upper limit to biomass with depth.

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VOLUNTEER SUPPORT AND ENHANCEMENT OF RESEARCH AND MONITORING ACTIVITIES OF THE NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM: PROGRAM IMPLEMENTATION AND IMPACT

The National Estuarine Research Reserve System (NERRS) is a federal-state partnership authorized under the Coastal Zone Management Act which maintains a network of biogeographically representative coastal and estuarine areas, managed in part for long-term research and monitoring. The various components of the National Research and Monitoring Program are enhanced through the implementation of volunteer programs locally. This study looks at the ways in which volunteer efforts have supported core and elective elements of the NERRS research and monitoring programs. Since 2007, volunteers have contributed over
100,000 hours to NERRS research and monitoring activities. Quantitative analysis of research and monitoring activities supported through volunteer-based programs is paired with reserve-specific case studies of volunteer efforts to illustrate the breadth and depth of the volunteer impact to the Reserve System. NERRS volunteer activity enhances the Research and Monitoring Program and promotes active stewardship among public audiences.

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**DEVELOPMENT OF A TOOL FOR BEACH MANAGERS TO IDENTIFY SOURCES AND LOCATIONS OF MACROALGAE AROUND SOUTHWEST FLORIDA BARRIER ISLANDS**

Beginning in 2003-2004, there were several episodes of unusually large masses of drift red macroalgae washing ashore the beaches of southwest Florida. Local agencies provided funding to study the natural and anthropomorphic factors responsible for large-scale beach strandings, involving nine institutions and 12 investigators. The findings presented here were part of this larger study, and focused on defining the macroalgae assemblages and biotopes to address the resource management question, “are drift macroalgal events local or imported?” When trying to determine the sources of drift macroalgae in the expansive target area of the Gulf of Mexico management tools to narrow the search were developed. The possible locations prior to this study were too large to target effectively using a haphazard approaches, and was not able to provide managers appropriate information. The sources in near Real-time. Thirteen stations were sampled bimonthly and were distributed around Sanibel, Captiva, and Estero barrier islands. Quantitative assessments of macroalgae (biomass, PAM, isotopes, species composition), the attached epibiont, and underwater video were recorded. Hydroacoustics and towed-video were used to produce benthic habitat maps, which along with the associated bathymetry, were used to determine the most likely sources for macroalgae attachment and propagation. Nearshore habitats were widespread, found to have suitable attachment substrates, sufficient irradiance, and close proximity to land based nutrients. With an available hydrodynamic model, we used the data collected to develop 4 scenarios explaining the probable location and sources of macroalgae. Based on the species assemblage, current patterns, benthic habitat maps, irradiance at depth, and proximity to land-based nutrients, the scenarios allow one to determine from the drift assembly stranded on the beach, the most probable locations (local or imported) and narrow the potential search area.

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**EVALUATION OF BACTERIOLOGICAL AND NUTRIENT CONCERNS IN NEAR SHORE WATERS OF A BARRIER ISLAND COMMUNITY IN SW FLORIDA**

The barrier island community of Captiva in SW Florida had a series of events in 2006-2007 which gave the general perception that near shore water quality was deteriorating. Several prolonged bacteriological beach advisories and large quantities of macroalgae washing up on the beaches, lead the community to question whether the presence of septic systems on the island were having significant impact on local water quality. The Captiva Community Panel received funding from the Lee Tourism Development Council and authorized SCCF Marine Lab to implement a two year water quality study which would help determine the significance of local pollutant sources on local water quality. SCCF Marine Lab monitored Gulf and estuarine water quality after rain events, during wet and dry season and evaluated instances of elevated bacteria and nitrogen. Groundwater monitoring wells were also installed at 21 sites to link surface water quality to groundwater quality. The study found elevated levels of nitrates in groundwater for areas with septic systems but no significantly greater levels of indicator bacteria. Rain events caused elevated levels of indicator bacteria in near shore surface water. Microbial source tracking efforts revealed sources of indicator bacteria in stormwater runoff were very diverse and a low percentage of samples showed the possibility of human fecal presence. The Captiva community were presented with a two pronged approach to improve local water quality. The first part of the approach would focus on reducing runoff from this developed island. The second recommendation was to reduce nitrogen discharges to groundwater from existing septic systems through source isolation and treatment or advanced wastewater treatment.

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**BENTHIC DIVERSITY, COMMUNITY PATTERNS AND TRENDS IN DELAWARE BAY AS REVEALED BY THE DELAWARE ESTUARY BENTHIC INVENTORY**

In summer 2008, extensive benthic grab and water column sampling was conducted throughout the Delaware Bay and River at 230 sites allocated in a probabilistic design based on salinity and bottom sediment strata. Benthic species composition, sediment characteristics and measurements of potential stressors (metals) were analyzed for using diversity indices and multivariate ordination techniques. Overall, 235 benthic species in 112 families and 9 phyla were identified. Five stations had 40 or more species, and the mean species richness was 14. The most diverse groups were: polychaetes (27 families, 79 species), amphipods (15 families, 35 species), bivalves (17 families, 27 species), and gastropods (15 families, 25 species). The mean abundance was 8,000 individuals per square meter, and the highest total was 142,000 per square meter at Egg Island Point, dominated by Sabellaria vulgaris and Polydora cornuta. The most abundant single species was Gemma gemma at 71,000 per meter squared near Nantucket Creek. Along-bay and river, species diversity was highest in the polyhaline region of the bay, decreased with lower salinity through the mesohaline zone, then exhibited greater variability in oligohaline and tidal freshwater reaches. The dominance by polychaetes, bivalves and amphipods was expected for the estuary’s mixed sand-silt sediment bottoms as well as from published studies, yet the abundances reported here are considerably higher than some previous reports. Together, these data comprise the most intensively sampled and comprehensively characterized assessment of the Delaware Estuary’s benthic fauna, and are especially valuable in comparison with previous surveys of Delaware Bay from the 1950s, 1970s and more regularly since the 1990s.

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**RELATING RESTORED FRESHWATER FLOW WITH MATERIALS EXCHANGE AND ESTUARINE WATER QUALITY IN THE SOUTHERN EVERGLADES MANGROVE ECOTONE**

Few quantitative tools exist to understand how restoring the quantity of freshwater flows to the Everglades will affect water quality of estuaries downstream. Florida Bay is more saline currently than it was historically, and reduced freshwater flows may lead to more phosphorus inputs to the mangrove ecotone from the marine end-member. This is important given planned restoration in the C-111 canal basin, which will prevent water losses from Taylor Slough, leading to an increased flow of freshwater into eastern Florida Bay. Our analyses focused on determining the relationships between salinity, nutrients, and hydrologic variables (stage and flow) in the mangrove ecotone of lower Taylor Slough. Based on research looking at seasonal patterns of water quality in this region, we expected that our analysis would more clearly establish that phosphorous levels would be positively correlated with salinity and negatively correlated with flow in the mangrove ecotone. Further, assuming that current S-197 outflows will be retained in the Taylor Slough and C-111 basin wetlands with full C-111 restoration, we could see 5 to 8% more water flowing into eastern Florida Bay. Despite expectations of increased flows improving the ecological health of lower Taylor Slough and Florida Bay, the dynamics of nitrogen (N) and phosphorus (P) within the mangrove system may shift in response to new conditions of flow, salinity and as well as organic carbon, N, and P availability. Our recent statistical and time-series analyses combined with past flux studies in this system indicate that P, CHLA, N and other nutrients do not always change linearly with salinity. N alters its behavior at the interface between the mangrove ecotone and Florida Bay; identifying possible underlying mechanisms such as nutrient processing within the ecotope, evaporative loading, and leaf litter decomposition that may regulate nutrient availability will provide additional information to guide restoration efforts.

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**FACTORS INFLUENCING OTOLITH ELEMENTAL INCORPORATION: IMPLICATIONS FOR FIELD APPLICATIONS**

Studies based on variation in otolith elemental composition are now common although the regulatory mechanisms of incorporation have yet to be fully elucidated. Laboratory studies on two marine (black rockfish Sebastes melanops and Pacific cod Gadus macrocephalus) and an anadromous (Chinook salmon Oncorhynchus tshawytscha) fish species were completed to examine the effects of temperature, salinity, and water concentration on otolith elemental incorporation. Observed patterns highlight the importance of species and potentially stage-specific effects. The one consistent observation was a positive relationship between otolith and water composition for Sr and Ba. Temperature effects were highly variable. For juvenile black rockfish, there were significant positive effects of temperature on the incorporation of Sr and Ba and negative effects for Mn. For larval Pacific cod, there were significant positive effects of temperature on the incorporation of Mg and Sr and negative effects detected for Mg. For juvenile Chinook salmon, there were significant interactions between...
temperature and salinity that influenced Sr and Ba incorporation and need to be considered when reconstructing migratory histories. When examined, the effects of somatic and otolith precipitation rate were generally non-significant although a negative effect of somatic growth rate on Ba incorporation was observed in Chinook salmon. In general, the results are contrary to expectations based on models of abiotic mineral growth and highlight the importance of metabolic effects. Given the clear presence of vital effects on elemental incorporation, it may be necessary to develop species-specific models of incorporation to provide the appropriate framework for field applications.

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ASSESSING IMPACTS OF A LIVING SHORELINE ON SHORELINE RETREAT AND SLOPE: A COMPARISON OF TECHNIQUES

With global warming and rising sea levels, coastal protection remains a global priority. In many coastal areas, this means that management priorities include the maintenance of shoreline integrity and reduction of shoreline erosion. A common tool to combat shoreline erosion involves armoring the land/water interface with hard structure. Recently however, the concept of creating living shorelines using native shellfish populations has led to numerous projects along the U.S. coasts to reduce erosion. Horizontal edge location and changes in shoreline morphology are two of the most common measures used as indicators of erosion and accretion, but are rarely measured simultaneously. Using edge location and change in shoreline morphology (slope, near shore sediment accretion), this project quantified shoreline retreat using edge location, slope, and sediment loss or accretion (change in volume) behind the living shoreline, and at a nearby reference site. Both sites experienced continued shoreline retreat (reference shoreline: 9 mm m⁻¹; living shoreline: 5 mm m⁻¹) and lost moderate volumes of sediment within the 432 m² survey plots (reference: 0.04 m³ m⁻² sediment loss; living shoreline: 0.03 m³ m⁻² sediment loss). Shoreline slopes remained low (< 0.01) throughout the study. While shoreline retreat provides a measure of actual erosion of land, change in shoreline slope and/or measures of sediment accretion and loss may provide critical information in understanding how a living shoreline may be affecting shoreline erosion, including changes to living shoreline morphology and sediment accumulation or loss patterns. The results of this study could be used to develop more effective monitoring strategies and to help better understand the effects of living shorelines on shoreline retreat.

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EFFECTIVENESS OF VIDEO-LIVE CONFERENCE TO DELIVER PROFESSIONAL DEVELOPMENT TO K-12 TEACHERS ON THE DEEPWATER HORIZON EVENT AT MULTIPLE LOCATIONS ACROSS THE GULF OF MEXICO REGION

Using video-conferencing technology, partners in 4 Gulf of Mexico states provided professional development on the Deepwater Horizon event to 171 K-12 teachers at 10 locations. This workshop occurred on a single day in April 2011 and will be repeated in the fall of 2011. Presentations by researchers in each state actively studying various aspects of the oil spill were followed by a question and answer session. Video conferences were then separated by state and informal educators or facilitators led participants through one or two activities suitable for the classroom/laboratory and relevant to the workshop content. An additional question and answer session followed these activities. Pre and post-testing was conducted online and was used to evaluate changes in content knowledge. Attitudinal evaluations were also completed online: results will be used to improve the fall workshop as well as to assess the success of this approach to professional development. Most participants were K-12 classroom educators (92%) while informal educators made up 6% of the audience. 89% of the participants rated the four research presentations as valuable or very valuable. The exception was a presentation that was delivered as a lecture with no accompanying graphics. For 3 states, more than 80% of the participants rated the hands-on activities as valuable or very valuable. Technical difficulties and personnel issues affected the implementation of these activities in the 4th state. More than half of the participants (61%) had never attended a workshop using video-conferencing technology, but 80% indicated that they would attend another.

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THE EFFECTS OF OYSTER REEFS ON ANNUAL PATTERNS OF BENTHIC METABOLISM AND NUTRIENT FLUX IN A GULF OF MEXICO ESTUARY

Oyster reefs provide several important ecosystem services, including providing habitat, reducing wave and current energy, and enhancing water quality. Oyster reefs may also affect ecosystem processes through their impacts on benthic-pelagic coupling. The effects of oyster reefs on benthic O₂ consumption and benthic nutrient flux were determined seasonally using a chemostatic microcosm system in which clumps of oysters and associated biota were added to field collected sediment cores. Oyster reefs significantly increased rates of benthic O₂ consumption in all seasons: this increase was most marked for the fall (88% of the total) and minimal during the winter (44% of the total). Oyster reefs significantly increased NH₄ release from the sediment in all seasons again being most pronounced in the fall (88% of the total flux) and minimal in the winter (39% of the total flux). Oyster reefs significantly increased benthic release of NO₃ in the spring and summer, reduced rates of uptake in the winter and increased rates of uptake in the fall. These results may be due to enhanced nitrification within the oyster reef matrix or stimulation of nitrification in the sediment. Oyster reefs resulted in a significant change in patterns of POC sediment flux, significantly increasing sediment release (summer, winter) or causing a change in direction from sediment uptake to a net release (fall, spring). Weight-rate regressions were not significant except during spring indicating that changes in benthic oxygen consumption, NH₄ flux and POC flux were not simply due to oyster excretion. At observed average densities of 150 g dry wt m⁻², oyster reefs supply all of the nitrogen required to support observed levels of primary production (2.5 g C m⁻² d⁻¹) in Fourleague Bay. Oyster reefs act as ‘hot spots’, areas with higher rates of nutrient transformation and benthic O₂ consumption, and may support critical ecosystem processes in estuarine environments.

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MODELING MICROALGAL ABUNDANCE WITH ARTIFICIAL NEURAL NETWORKS: DEMONSTRATION OF A HEURISTIC ‘GREY BOX’ TO DECONVOLVE AND QUANTIFY ENVIRONMENTAL INFLUENCES

Aquatic scientists traditionally have relied upon linear, multivariate regression models to provide functional approximations of microalgal-environmental relationships. Such ‘white box’ models provide users with a comfortable degree of model transparency via a defined mathematical structure with generated coefficients. Yet, despite their holistic deficiency in explicit or declarative knowledge structure, artificial neural networks (ANNs) have become popular tools over the last decade for modeling microalgal abundance dynamics as a function of environmental ‘predictors.’ Clearly, a heuristic knowledge-extraction technique that provides quantitative formulations pertaining to variable interaction and prediction influences for ANNs is desirable; such an approach would allow for a mathematically comprehensive, yet pragmatic understanding of environmental-biota complexity and interaction, whilst eliminating the ‘black box’ mentality for ANNs. Here, we present a network-based approach - a ‘Grey Box,’ demonstrating the iterative selection, depiction, and quantitation of environmental relationships in modeling water-column chlorophyll a for a dynamic coastal environment. The ‘Grey Box’ formulation is based upon knowledge extracted from trained, validated and tested ANNs, provides interpretable, multi-dimensional response surfaces depicting modeled environmental-chlorophyll relationships, and quantifies the environmental influences and interactions for chlorophyll a through the summation of the response-surface equations.

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SEEDMEN AS FILTERS OF APPLIED NITROGEN FROM DISCHARGING GROUNDWATER TO LOW-RELIEF COASTAL STREAMS

This study quantified the contribution of these streams to the enrichment of nitrate concentrations in the sea-side lagoons and to determine the hydrological and watershed land-use factors that most affect nitrate loading. Thirteen watersheds were selected for nutrient sampling and discharge measurements, ranging in size from 213 ha to 1971 ha. Selections were made so that a range of watershed areas and land-use categories within each class of watershed areas would be obtained. Continuously recording stream gauges were installed in 4 of the streams. Synoptic surveys determined N₀, concentration and discharge at stream locations downgradient in the watershed but uninfluenced by tidal effects. We determined empirical relationships between stream discharge and watershed area in each of our metered watersheds and used a regression of these relationships to estimate discharge for the entire contributing portion of the Virginia’s Eastern Shore. Discharge values were used to estimate discharge downstream by as much as a factor of 23 and temporally for a single stream up to a factor of 14.
Nitrates concentrations ranged from 0.14 mg/L to 9.4 mg/L. In all but one sampling survey, the two streams with the lowest nitrates concentrations drained watersheds with the greatest fraction of forested land as compared with cropland, developed land, and miscellaneous other land uses. Estimated annual nitrates loadings to the lagoons based on individual surveys ranged from 5.2x10³ kg to 2.2x10⁴ kg, varying primarily due to seasonal stream flow fluctuations. Comparisons between N-loading predictions made using measured stream nitrates concentration values and spatially-averaged concentration values in individual watersheds differed by less than 9% in all instances, indicating that stream discharge controls overall nitrates loading better than specific nitrates concentration.

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LIVING SHORELINES: INTEGRATING CURRENT RESEARCH INTO EDUCATION AND OUTREACH PROGRAMS AT THE DAUPHIN ISLAND SEA LAB

Researchers and educators at the Dauphin Island Sea Lab (DISL) and its Discovery Hall Programs (DHP) have developed an integrated research and education program for a large-scale oyster reef restoration study in Mobile Bay and Mississippi Sound. The purpose of this study, managed by The Nature Conservancy and funded through the National Oceanic and Atmospheric Administration, is to investigate the effectiveness of different oyster reef restoration techniques in the establishment of living shorelines along the northern Gulf of Mexico. A new program has been integrated into our existing education programs for school-age children and workshops for educators allowing students and teachers to investigate living shorelines, oyster biology, restoration science, and the ecology of oyster reefs, salt marshes and seagrass habitats. The curriculum, aligned with the Alabama Course of Study Standards and Ocean Literacy Principles, is used in DHP’s academic year and summer programs, including: (1) Marine Science – a residential class for high school students; (2) Art-Sea Discovery – summer camp; (3) The Salt Marsh – academic year class; and (4) Reefs, Rhizomes and Restoration - a Mississippi-Alabama Sea Grant Consortium-sponsored teacher workshop. Exhibits highlighting this research are on display at The Estuarium, DISL-DHP’s public aquarium which entertains and educates an average of 66,000 visitors per year. An outdoor exhibit provides examples of each restoration technique being investigated, including a ReefBLK, Reef Ball, and bagged oyster shell, along with permanent fiberglass interpretive signage. The signage highlights oyster biology, oyster reef habitat, ecosystem services provided by oyster reefs, and the potential benefits of using oyster reefs as living shorelines. An audio kiosk accompanies the display. Inside, short videos describe reef design and construction, pre- and post-monitoring results and associated education activities.

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OPTIMIZING UNDERGRADUATE RESEARCH AND EDUCATION IN THE GEOSCIENCES

Incorporating undergraduates into a research program in the geosciences, while challenging, can be incredibly rewarding for a mentor as well as student. Proper mentoring should ideally be conducted from the perspective of intellectual growth of the student and making the student more marketable for their future plans. Ideally, these goals should be aligned with the laboratory, fish were exposed for 4 weeks to hypoxia (dissolved oxygen (D.O.) – 1.7 mg/L) or normoxia (D.O. – 6 mg/L) in recirculating seawater tanks. Otolith material representing the experimental period was analyzed with laser-ablation inductively coupled plasma mass spectrometry (LA-ICP-MS). Wild fish were also collected at sites in the “Dead Zone” of the Gulf of Mexico with varying dissolved oxygen levels (D.O. range 0.7 – 6.3 mg/L) during October 2010. Wild otoliths were examined by LA-ICP-MS from the core to edge to extract lifetime chemical profiles. Correlations between ambient D.O. and otolith chemistry were examined and compared between wild and laboratory fish. This study presents preliminary observations on the potential for otolith chemical composition to indicate exposure to hypoxia. Validating a permanent chemical marker in fish indicating duration and severity of hypoxic exposure, in combination with physiological biomarkers of reproductive impairment, would further our understanding of population wide responses to hypoxia and the potential consequences for ecosystem functioning.

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COMPARATIVE STUDIES OF DIAMONDBACK TERRAPIN (MALACLEMYS TERRAPIN) POPULATIONS ACROSS THEIR RANGE

Diamondback terrapins (Malaclemys terrapin) are a small species of turtle endemic to coastal salt marshes and mangroves along the US Atlantic and Gulf Coasts. Terrapins are a key component of the salt marsh ecosystem: they are top predators in salt marsh food webs, impose top-down control of marsh productivity, are a sentinel indicator of ecosystem health, and have a unique evolutionary/ecological status as the only turtle endemic to temperate brackish water habitats. As a species with a broad latitudinal range, terrapin populations experience greater seasonal differences in climate, habitat, and tidal regime, as well as other factors that may significantly influence their life history, ecology, and behavior. Many terrapin populations are along the mid- and southeastern-Atlantic Coast have been well studied, however, data are severely lacking for other locations. We are currently studying two terrapin populations in Marine Protected Areas within understudied portions of their range, one in the Grand Bay National Estuarine Research Reserve along the Mississippi coast and another in the Florida Keys National Wildlife Refuge/Florida Keys National Marine Sanctuary. Studies of the Florida Keys population, including mark-recapture, began 30 years ago, while studies in Mississippi were initiated approximately five years ago. Current research focus includes long-term demographic studies, nesting ecology, genetics, and contaminant burdens. We have identified important differences in terrapin life history and ecology, including: hibernation period, nest site selection, feeding ecology, and mercury burden between Atlantic, Gulf, and Florida Keys populations, highlighting the importance of regional comparative studies for wide-ranging species.

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IDENTIFYING NITROGEN SOURCES TO THERMALLY-HEATED TIDE POOLS ON HAWAII ISLAND USING A MULTI-STABLE ISOTOPE APPROACH

Eutrophication of coral reefs is a worldwide problem. In Hawaii, it is a concern because of increasing development, agriculture, and wide-spread use of cesspools. Therefore, determining nitrogen (N) sources to coral reefs is important for their management and sustainability. The objective of our study was to identify N sources entering thermally-heated, coral reef tide pools in Kapoho, Hawaii, and determine their relative importance. Possible N sources to the tide pools included: fertilizers, soils, seaweed, fish, and water, and each had unique values for δ15N and δ18O in NO3- and δ18O in NH4+. Areas of groundwater input
to the tide pools were identified by high-resolution spatial water quality mapping and they were warm and had high nutrient concentrations. In the two areas of highest groundwater inputs, surface water and macroalgal tissues were collected along 100-m transects starting at the coastline for three consecutive summer months at low tide when groundwater influence was greatest. Water samples from tide pools and N sources were analyzed for nutrient concentrations, δ15N and δ18O in NO3-, and δ11B, while macroalgae tissues were analyzed for δ15N. Results from these analyses suggest that sewage and fertilizer N were present in the tide pools, but that macroalgae were enriched with fertilizer N. Spatial extent of the pollution and the relative contributions of the N sources to tide pool waters temporally are currently being determined. This multi-stable isotope approach for identifying N sources to tropical tide pools was successful and may be useful in other coastal waters worldwide.

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DEEPWATER HORIZON OIL AND PELAGIC FOODWEBS IN THE NORTHERN GULF OF MEXICO: WHAT DO STABLE ISOTOPES TELL US ABOUT OIL, SUBSURFACE TURBID LAYERS AND DISCOLORED ZOOPLANKTON?

The Deepwater Horizon spill was the largest marine oil spill to date, leading to the release of some five million barrels of oil at an offshore site in the Gulf of Mexico. The release of oil under high pressure at a depth of about 1500 m led to formation of significant surface slicks, subsurface plume-like layers containing dispersed oil, and bottom deposits of oil-derived materials in the Northern Gulf of Mexico. During a cruise to the northern Gulf of Mexico shortly after the flow of oil was halted (21 Aug - 16 Sep 2010), we collected samples of suspended particles and zooplankton for elemental and isotopic analysis. At sea, we encountered multiple subsurface features characterized by low beam transmittance, distinct spectral fluorescence signatures, and high concentrations of particles. These features appeared to form coherent layers below the mixed layer at depths ranging between roughly 150 and 1400 m and extending in all directions around the Deepwater Horizon wellhead. Although these layers appear spatially linked to the Deepwater Horizon oil spill, they were not consistently associated with high concentrations of methane and other hydrocarbons associated with the spill. Many of our zooplankton samples were discolored, and gelatinous animals were particularly likely to have an unusual brown to black coloration. We will discuss the hydrographic context of our samples and their elemental and isotopic composition, which provide a measure of the biogeochemical impact of the spill on pelagic foodwebs in the Northern Gulf of Mexico.

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EXPLORING THE ROLE OF RIBBED MUSSELS (GEUKENSIAS DEMISSA) IN SALT MARSH STABILIZATION

Marsh erosion is a major concern for estuaries as increasing storm severity, boat wakes, and sea-level rise threaten shorelines. The ribbed mussel Geukensia demissa is a prominent component of the Delaware Bay estuarine ecosystem, where it exists in a synergistic relationship with the marsh grass Spartina alterniflora. The mussels deposit nutrient rich feces that enhance production of S. alterniflora creating levees along the marsh edge which trap sediments enhancing vertical accretion. The physical structure formed by aggregations of ribbed mussels may provide stability to the marsh edge, but information concerning the role of G. demissa in protecting marsh edge is lacking. To test the hypothesis that salt marsh shoreline erosion decreases as mussel density increases within an energy regime, mussel densities and demographics, mass transport rate, annual lateral shoreline movement, nutrient concentrations, and below ground biomass were quantified along shorelines of the Delaware Estuary (n ~ 12 sites). Potential relationships between these factors are being evaluated within and among study sites using a Bayesian Hierarchical Modeling method. The aim is to characterize demographics of ribbed mussels that stabilize shorelines at...
different spatial scales and under different erosive conditions. Results will help determine the potential role of using marsh mussels as a living shoreline fortification to reduce coastal erosion and permit natural accretion of the marsh surface.

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SHORELINE LOSS INDUCES CHANGES IN SALT-MARSH FLORAL COMMUNITIES

The loss of salt-marsh habitat in the northern Gulf of Mexico is proceeding at an alarming rate, resulting in the loss of ecosystem function and reduced connectivity with adjacent habitats. Shoreline erosion severely impedes the development and sustainability of salt-marsh habitats, leading to the loss of floral diversity and the vital ecosystem services they provide. The immediate result of shoreline erosion is the loss of fringing vegetation but it is unclear how, and at what temporal scale, upland floral zones respond to shoreline loss. Using a transect-based approach, we investigated the dynamics of dominant floral zones among three intertidal salt marshes that lie along a gradient of wave-generated disturbance from 2009 to 2010. Sites that experienced high rates of shoreline erosion (>1.0 mm/yr) exhibited a significant decline in the coverage of upland climax communities and high zonal compaction (i.e., encroachment of upland species zones and bare marsh surface by low-intertidal species). Trajectories of community change for sites that exhibited intermediate rates of shoreline erosion (0.5–1.0 mm/yr) were contingent on the height of shoreline erosion. Sites with high escarpments exhibited stable zones of high-intertidal species, but experienced significant zonal compaction. Sites lacking substantial shoreline erosion exhibited a decline in upland monospecific zones and replacement by mixed-species assemblages and early colonizers. The marsh edge not only provides vital habitat to a diverse assemblage of ecologically and economically important species, it also protects and maintains the integrity of upland vegetation zones. The incorporation of community indicators derived from this study into current monitoring schemes will fail a critical role in the early detection of stressed and degraded habitats in the northern Gulf of Mexico.

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NUTRIENT AND ORGANIC MATTER DYNAMICS FOLLOWING STORM EVENTS IN THE MISSION-ARANAS NATIONAL ESTUARINE RESEARCH RESERVE (NERR), TEXAS

Rivers deliver a disproportionate amount of freshwater, nutrients, and organic matter to the coast during storm events. This is especially important in South Texas where one storm event can at times contribute the majority of freshwater for an entire year, or the lack of storm events can turn estuaries hypersaline. Understanding nitrogen (N) dynamics from inflowing rivers to estuaries is important to understanding and managing increasing coastal productivity and eutrophication. The role of storm events in watershed export and estuarine response was examined with an emphasis on N cycling in the Mission-Aransas NERR, a riverine-estuarine system in South Texas. Following major storm events in 2007 and 2010, estuarine nutrients, dissolved organic carbon and N, and chlorophyll-a concentrations were elevated. Nitrate and ammonium (NH4+) concentrations increased but quickly declined, while phosphorus concentrations remained elevated for months after the storms. Measurements of water column NH4+ uptake and regeneration in the estuary and its inflowing rivers revealed that NH4+ uptake increased from upstream to the mouth of the estuary, and then declined in the bay prior to a major storm (80, 230 and 100 umol N m-3 h-1, respectively). NH4+ uptake rates declined during the storm as a result of increased N availability (75, 83 and 41 umol N m-3 h-1, respectively in the river, river mouths and estuary). Sediment denitrification rates in the estuary were stimulated after the flood. However, the estuary switched to net N-fixation in February 2011, when N concentrations are low. This study demonstrates the importance of sampling during storm events and suggests that storm inputs support increased estuarine production for extended periods after events.

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MAPPING FINE-SCALE VARIATION OF POLEWATER SALINITY IN TIDAL MARSHES VULNERABLE TO EXOTIC PHRAGMITES INVASION USING ELECTROMAGNETIC INDUCTION

Electromagnetic induction was used to measure apparent conductivity of soil pore water within 15 oghogaline to polyhaline tidal marshes of the Great Bay Estuary in New Hampshire, USA. The instrument was linked to a differential global positioning system via a hand-held field computer to geo-reference data. Apparent conductivity was converted to salinity using a regression derived from field data, and mapped to illustrate spatial salinity gradients throughout the marshes. Plant communities occurring at the study sites included native low marsh, high marsh, and brackish tidal riverbank marsh, as well as communities dominated by native and non-native common reed, Phragmites australis. Results revealed mean salinity values were significantly different between each of the community categories sampled within the Estuary. Due to management concerns over expansion of Phragmites within the Estuary, we mapped the salinity range for this community and provided graphic and numerical estimates of potential Phragmites habitat based on salinity alone (26% of the total acreage surveyed). Electromagnetic induction is an efficient tool for rapid reconnaissance of apparent conductivity and salinity gradients in tidal marsh soils that can be superimposed on aerial imagery to estimate suitable habitat for restoration or invasive control based on salinity ranges.

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THE INTERACTIVE EFFECTS OF NATURAL AND ANTHROPOGENIC STRESSORS ON EELGRASS PERSISTENCE

Declines in seagrass populations worldwide have been related to a variety of natural and anthropogenic stressors. The temperate seagrass species, eelgrass (Zostera marina L.), has been shown to be sensitive to high summertime water temperatures in regions such as the Chesapeake Bay, where the species is near the southern limits of its range. Here we use a model relating temperature dependent eelgrass community compensating light requirements to light availability applied to three different sites located along a gradient of turbidity in one Chesapeake Bay tributary. Regular measures of eelgrass abundance are compared to the balance between compensating light requirements and light availability determined using in situ, continuous measures of turbidity and temperature at each site. Unusually high water temperatures during periods in the summers of 2005 and 2010 corresponded to significant diebacks of eelgrass at the most downstream site where beds had been persistent. Upstream areas with higher turbidities (lowest light attenuation) and greater imbalances between light availability and light requirements showed even greater effects. While the most downstream site with the greatest light availability demonstrated recovery during intervening years with more average summertime temperatures, little recovery was evident at the more turbid upstream sites. Projected increases in water temperatures combined with high levels of turbidity, even in the short term during the summer, that may be related to climate change or other factors, pose serious long-term threats for eelgrass in this and other coastal systems.

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EFFECTS OF MORPHOLOGY ON TIDAL DISTORTION AND ENERGY DISSIPATION IN A TIDAL CREEK SYSTEM

The role of channel and adjacent intertidal marsh morphology in tidal distortion of the M2 component is examined by harmonic analysis and calculations of the tidal energy dissipation. Six stations recorded water level and current velocity in a branching tidal creek network in coastal Georgia. There is an overall upstream decrease in the M2, M4 and M6 tidal constituents. Total upstream energy flux decreased with distance from the channel mouth, with abrupt decreases where the main channel forks into three smaller creeks. This finding indicates that the extent and physical character of intertidal marshes and sloughs is a significant energy dissipation sites. Accurate three-dimensional channel and intertidal-area
A shift in the metabolic regulation of free Sr$^{2+}$. We propose that the high levels of Sr in the fish encompass the entire fish life. High concentration levels of Sr were measured in the otoliths and the sagittal otoliths extracted. Laser ablation-ICP-MS analyses were done to determine Sr concentration of the European flounder in the estuary and in the adjacent coastal area. Fifteen specimens were collected from three sampling areas (freshwater and coastal area). These diagrams reflect the effects of friction and geomorphic landscape features such as intersecting creeks, overtopping of creek banks, and distance from the channel mouth. Predictive power of benthic analyses is compromised by factors such as records that are too short and wind effects. Deviations from the predicted tidal water level and current velocity values (residuals) were the most pronounced and noisy for the instruments with short records. Changes in subtidal-frequency water level induced by the alongshore component of continental shelf winds cause setup and setdown responses in the waterhed and significantly increase the offset between observed and predicted water level.

**WHEN OTOLITH MICROCHEMISTRY ANALYSIS REVEALS THE UNEXPECTED:**

Assessing the diversity of European flounder (Platichthys flesus) migration patterns allows determining characteristics of the species’ ecology and provides useful information for fisheries managers. This species is an important estuarine fishery in the Minho estuary (N-Portugal, Europe) and we aimed to determine the diversity of migration patterns of the European flounder in the estuary and in the adjacent coastal area. Fifteen specimens from three sampling areas (freshwater and coastal area) were collected, and the sagittal otoliths extracted. Laser ablation-ICP-MS analyses were done to determine the concentration of strontium (Sr) from the core to the poststratum edge of the otolith, to encompass the entire fish life. High concentration levels of Sr were measured in the otoliths core of estuarine specimens, following an abrupt decrease of Sr. We do not attribute the high Sr levels to the hatching of larvae in high salinity waters, neither the abrupt decrease of Sr to a shift in the metabolic regulation of free Sr$^{2+}$. We propose that the high levels of Sr in the otoliths’ core reflect the higher salinity conditions of where the female progenitor hydrated the eggs, while the abrupt decrease would correspond to the low salinity conditions of the hatching ground. This interpretation suggests that some of the female progenitors were “sea-run mothers,” i.e. they migrated from the coast into the estuary to spawn. According to this hypothesis, all the specimens collected in the Minho estuary hatched in an estuarine environment, while only 6.7% of those fishes captured in the coastal area hatched in the coast. Thus, the European flounder might spawn in estuarine and coastal areas and not just in coastal areas as was previously widely accepted. Studies aimed at collecting larval stages and adult flounders must be made to confirm that flounders spawn in the estuary and to define new and better scientifically supported fishing policies.

**LAND-USE IN THE WATERSHED AND COASTAL ECOSYSTEM HEALTH IN A KARSTIC SCENARIO OF THE YUCATAN PENINSULA, MEXICO**

The north coast of Yucatan Peninsula is a karstic scenario where the water flows mainly underground through the so called cenotes-ring system (“sink holes”) toward the coast. This underground water system enhances the connection between watershed condition and coastal ecosystem health. Inland activities such as livestock, agriculture and urban development produce changes in the landscape, hydrological connectivity and in the water quality that can decrease mangroves and seagrasses coverage, as well as favor eutrophic symptoms as appearance of harmful algal blooms. We conducted studies on the condition of Celestun and Dzilam coast, both located in the discharge ends of the cenotes-ring system, but under different watershed impacts. We evaluated water quality indicators (ASSETS, TRIX, EPA water quality), habitat (seagrasses and mangroves coverage) and vulnerability to harmful algal blooms (number and abundance of harmful species). Our results show that in highly urbanized areas mangrove coverage has been reduced up to 60%, the aquatic vegetation has suffered phase-change from seagrasses to green-algae, and eutrophic symptoms as high chlorophyll-a concentrations and harmful algal blooms have been registered. Through GIS tools (Marxan, ARC View) we explore the relationships between land use and coastal condition in order to determine priority areas for conservation within the watershed that could be ecologically efficient in order to preserve the health of this coastal karstic area.

**LANDSCAPE-LEVEL SATURATION IN NITROGEN UPTAKE CAPACITY OF SALTMARSHES WITH CHRONIC NUTRIENT ENRICHMENT**

Saltmarshes are vital components of the coastal landscape and serve to buffer adjacent aquatic systems from nutrient loading by removing nitrogen (N) through plant growth, sequestration in sediment, and denitrification. However, the effect of chronic anthropogenic nutrient enrichment (eutrophication) on the capacity of marshes to remove N is not known. To understand how a suite of ecosystem components are affected by anthropogenic nutrient enrichment, the TIDE experiment has for 8 years experimentally enriched the tidal water that semidiurnally floods replicate saltmarsh creekheads (n=3; 1 primary creek channel and 30,000 m² of saltmarsh per experimental unit) in Plum Island, MA, Gulf of Maine. Nitrate concentration was elevated from 5 µM to 70-100 µM, phosphate from less than 1 µM to 5 µM. To assess how the nutrient retention capacity of these marshes has been altered by chronic enrichment we compared the nutrient flux in flooding and ebbing water using autosamplers, current profilers, and an in situ nitrate sensor in reference marshes and a chronosequence of marshes enriched for 1 to 8 y. We also challenged nutrient enriched marshes with 3 levels of enrichment to determine how the short-term nutrient removal capacity of marshes was altered after 7 y of chronic enrichment. Nutrient retention comparisons suggest a landscape-level saturation in the capacity of marshes to remove nitrate with nutrient loading. The level of N removal was higher when tidal water flooded the Spartina patens platform than on tides flooding only the channel and S. alterniflora. Landscape-level N uptake quickly reached an asymptote of N removal compared to loading in both reference and enriched marshes, but the maximum uptake was much higher in enriched marshes than in reference. These results suggest that the capacity of marshes to remove nutrients, while initially high, is not unlimited, a finding that mirrors the N saturation phenomenon known to occur in temperate forest ecosystems.

**17 YEARS OF THERAPY: SEAGRASS MONITORING IN THE INDIAN RIVER LAGOON, FL**

Two methods are used to monitor over 300 km² of seagrass in Florida’s 250-km long Indian River Lagoon (IRL) system. Photo-interpretation of aerial photos every 2-3 years provides a lagoon-wide status of seagrass coverage and depth of beds. The 100 fixed seagrass transects, spaced throughout the IRL and monitored twice a year (summer and winter), are intended to detect spatial and temporal changes in species depth distribution, abundance, and diversity. Over the past 17 years of monitoring, the results from the two methods have been mostly complementary, with both showing positive trends in the seagrass coverage footprint. The mapped seagrass coverage has increased by over 24,000 acres (31%) and the total bed width (transsect length) has increased by 80 m (36%), which is concurrent with an increase in seagrass depth limits by 0.3 m (23%). However, in other response parameters there are inconsistencies with these positive trends. For example, seagrass density (% cover) has declined lagoon-wide an average of 33% from its initial value (44% cover in 1994 vs. 29% cover in 2010), with declines greater than 60% of their initial value in some segments. This decline in density is consistent at 50% of the 30 transect sites monitored by both methods. This study has been ongoing since 1993 and continues to follow the recovery of these ecosystems.
decline has become most evident during the last decade. Concomitant with the decline, there has been a lagoon-wide increase in the coefficient of variation to more than 55%. In addition, all the response parameters have different temporal patterns and trends at various spatial scales (e.g., lagoon-wide vs. lagoon segments). Ultimately, it is these differences, between good and bad years, and, within and between lagoon segments, that have been used to meet the challenges of setting area-sensitive seagrass coverage, depth, and density targets.

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DEVELOPING AND IMPLEMENTING A SEDIMENT QUALITY MANAGEMENT STRATEGY FOR A REGIONALLY IMPORTANT BIRD FORAGING AREA: MCKAY BAY, FLORIDA

McKay Bay is a highly urbanized embayment located in the northeastern portion of Tampa Bay. Unlike nearby areas, which have been extensively dredged for commercial shipping and flood control purposes, much of McKay Bay consists of shallow, undredged mudflats surrounded by mangroves and salt marshes. During winter low tides the shallow flats are often exposed, providing a regionally-important feeding area for large numbers of resident and migratory shorebirds, waterfowl and wading birds. Sediment quality data provided by federal, state and local monitoring programs indicate that several contaminants are present at elevated concentrations in the area, and initial ecological and human risk assessments have identified low- and high-molecular weight PAHs, PCBs, and several metals and pesticides as contaminants of concern (COCs). The Tampa Bay Estuary Program and its partner organizations have identified the area as their highest priority for the development and implementation of a sediment quality management plan. A multi-stakeholder working group has developed an initial management plan for the area, based on current NRC and EPA guidance, which focuses primarily on controlling external COC sources and monitoring COC levels in water, sediments, and food web components to support the development of more detailed risk assessments. Going forward, the sediment management effort will be required to balance a number of key issues such as minimizing risks to human and wildlife health, maintaining the quantity and quality of regionally important avifaunal habitat, identifying and implementing cost-effective methods for remediating existing hotspots of soil and groundwater contamination in the highly-urbanized watershed, developing and implementing (if necessary) a sediment remediation program, and doing all these things in the presence of significant economic and socio-economic constraints.

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MICROBIAL MUNCHIES, HOW CARBON LABILITY DETERMINES THE FATE OF NITRATE IN WETLANDS

Wetland systems have the capacity to remove large quantities of excess nitrate from surface waters. This ability of wetlands to decrease nutrient loads, preventing downstream eutrophication and coastal hypoxia, has made these ecosystems targets for conservation and restoration. However, the microbial ecology that underlies this valuable ecosystem service is still understudied. The current study used organic matter and nitrate amendments to investigate the regulation of denitrification, and dissimilatory nitrate reduction to ammonium (DNRA) in freshwater wetland soils. Wetland sediment was amended with organic matter of variable lability (compost, leaf litter, or wood) and/or slow release nitrate (KNO3) fertilizer and incubated in situ a minimum of three months. Upon recovery, samples were analyzed for functional group abundance (qPCR), community structure (TRFLP), and activity (anoxic slurry assay utilizing 15N). Denitrifiers dominated the ecosystem, but DNRA-capable organisms were present in appreciable numbers, and both groups were responsive to treatments. For example, two-way ANOVA on the relative abundance of functional groups found a significant interaction between organic matter and nitrate (p < 0.05). The importance of organic matter was further evidenced by analysis of denitrifier community composition which significantly correlated with sediment percent organic matter. Stable isotope analysis also found nitrate and/or organic matter treatments had a significant impact on 15N nitrous oxide production rates, and this change in microbial community function could potentially impact nitrogen cycling at the ecosystem scale. Overall, this work indicates the fate of nitrate in wetlands is dependent upon the microbial ecology which is strongly influenced by organic matter. These relationships are important drivers of nitrate reduction, affecting how wetlands attenuate nitrogen loading, which could have implications for eutrophication of coastal habitats.

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NATURALLY OCCURRING MARINE ORGANIC SUBSTRATES ENHANCE MICROBIAL DEGRADATION OF MACONDO WELL CRUDE OIL

The explosion of Deepwater Horizon platform caused a massive oil spill that contaminated shorelines along the northern Gulf of Mexico. We determined rates of aerobic degradation of crude oil from the Macondo well by naturally occurring microorganisms in sandy beach environments and the extent to which the rate of crude oil degradation could be enhanced by supplying the microbial community with naturally occurring marine organic matter (OM). Replicated mesocosms consisted of four treatments: (i) controls (beach sand), (ii) sand contaminated with crude oil (4000 mg/kg), (iii) sand plus OM (400 mg/kg of fish tissue: Atlantic bunker), and (iv) sand plus crude and OM. CO2 production was measured daily over a six-week period in all treatment and the carbon isotopic ratio of respired CO2 (δ13CO2) was used to determine the fraction of respired CO2 that was derived from respiration of the crude oil. Enumeration of aerobic microbial communities for alkane, total hydrocarbon, and polycyclic aromatic hydrocarbon degraders was determined with the most probable number method. During the first three weeks crude oil degradation rates, in the crude amended with organic matter were at least 3-fold higher compared to the rate in the crude only treatment. The overall mineralization rate at the end of the experiment was 66% higher in the organic matter amended crude oil treatment compared to crude oil only additions. In the presence of crude oil, hydrocarbon degradation by sand samples, based on δ13C and δ15N magnitude. The 13C of respired CO2 indicated that in the crude amended with organic matter treatment crude oil was used as a cometabolite and respired. These data demonstrate that bioremediation of crude oil can be considerably enhanced by the addition of marine organic substrates and can be used as an effective bioremediation strategy.

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NITROUS OXIDE FLUXES FROM COASTAL MARSHES WITH PULSED OR CHRONIC NUTRIENT ADDITIONS

As anthropogenic nutrients reach coastal wetlands from rivers, groundwater, and atmospheric sources, they may stimulate microbial processes (such as denitrification and nitrification) that produce the greenhouse gas, nitrous oxide (N2O). N2O depletes stratospheric ozone and has about 300 times more global warming potential (radiative forcing) per molecule than CO2. Recent experiments have shown that short-term nutrient additions in a Spartina patens marsh at Plum Island Estuary, MA significantly increased fluxes of N2O (averaging 42 μmol N m⁻² day⁻¹) relative to control plots (0 μmol N m⁻² day⁻¹). With methane fluxes, these were comparable to about 1/2 of typical daily C sequestration rates of marshes, which suggests that nutrient loading can significantly affect the climatic roles of wetlands. However, N2O fluxes from two marshes with chronic nutrient loading were more complex. In a S. patens marsh at Plum Island Estuary with 7-8 years of fertilization (25X background nutrient fluxes), summer N2O fluxes were from -10 to +51 μmol N m⁻² day⁻¹. N2O fluxes were insignificant in an adjacent unfertilized marsh. In Sippewissett marsh on Cape Cod, which has been fertilized for 31 years at a range of levels, N2O fluxes from short-form S. alterniflora plots varied from -1.0 to +1.0 μmol N m⁻² day⁻¹ in unfertilized controls, to 34 μmol N m⁻² day⁻¹ at intermediate fertilization levels (2.53 mg N m⁻² wk⁻¹) and -290 μmol N m⁻² day⁻¹ at highest levels (7.56 mg N m⁻² wk⁻¹). These results indicate that short-term or moderate levels of nutrient loading can significantly enhance N2O fluxes from salt marshes, however, there may be critical thresholds below or beyond which marshes act as substantial sinks of N2O. Such information is needed to predict how climatic roles of coastal marshes may vary under different watershed management scenarios and how they may shift in the future.

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VARIABILITY OF SUSPENDED SEDIMENT CONCENTRATION IN SUISUN BAY, CALIFORNIA, AND THE RELATIVE INFLUENCES OF TIDES, METEOROLOGY, AND RIVER DISCHARGE

This paper presents an analysis of long-term monitoring datasets from Suisun Bay in San Francisco Bay, California. The study revealed several insights into variability of suspended sediment concentration (SSC) on daily, subtidal, and seasonal timescales. Surface and bottom SSC are very closely linked in winter, but less so in spring, summer, and autumn. Wintertime subtidal SSC variability is controlled strongly by precipitation and river discharge. During summer months, control of SSC shifts to another forcing mechanism not apparent given the available datasets. Dispersion of wind-wave resuspended sediment from...
the shallows and seasonally-developing vertical gravitational circulation are suspected. Fortnightly and monthly tides control background and tidal SSC. The influence of wind on SSC comprises a very small proportion of the total subtidal variability, but is statistically significant at certain frequencies. A combination of wind, discharge, and tides explained up to 75% of the variance in subtidal SSC.

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EFFECTS OF MULTIPLE INTERACTING GLOBAL CHANGE FACTORS ON INTRODUCED PHragmites australis

The invasion of the introduced lineage of the common reed, Phragmites australis results in disruptions to critical ecosystems services in tidal marshes along the North American coast. Contrary to previous hypotheses, recent research has indicated that sexual reproduction and establishment from seeds may be the primary mechanism driving Phragmites invasion. To evaluate how the establishment and growth may change in the future, we conducted a factorial marsh organ experiment using Phragmites seedlings in a brackish Chesapeake Bay marsh simulating sea-level rise, nitrogen (N) pollution, and elevated carbon dioxide concentrations (CO2). We found that both elevated CO2 and N pollution significantly increased plant growth and that these global change factors have the capacity to exacerbate the establishment and growth of Phragmites in tidal wetlands, with N pollution yielding the greater response. We also observed significant CO2×N×Sea Level Interactions, in which CO2 and N stimulated plant growth within a limited range of relative sea-levels. In particular, when plants were grown outside the optimum flooding regime, increased flooding or a lack of water availability negated the influence of elevated CO2 and N. Thus, enhancements in growth attributed to elevated CO2 and N pollution are not likely to overcome the effects of increased flooding due to sea-level rise. These data suggest that global change will have more influence on Phragmites invasion success near this species optimum elevation than at elevation extremes.

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SEASONAL AND SHORT-TERM DYNAMICS OF PHYTOPLANKTON PRIMARY PRODUCTION IN THE ATLANTIC SEA - NORTH SEA TRANSITION DEPENDS ON TAXONOMIC COMPOSITION AND A SUITE OF EXTERNAL FORCINGS

A two year baseline survey (21 cruises) of phytoplankton was carried out prior to a 4 year major dredging operation (20 million m3 seabed materials) associated with a construction of a tunnel between Denmark and Germany. After collating a large synoptic dataset (group composition by pigments, primary production by 14-C incubations, inorganic nutrient concentrations, water column stability, light availability, nutrient upwelling estimated from numerical modelling, benthic grazing potential etc.; N = 157) we used multivariate (PLS) regression to quantify the biomass specific activity of taxonomic groups across seasons, and the influence of hydrographic, chemical and biological forcings on primary production parameters. Within seasons the Chl-a specific production varied among taxonomic groups within a 2-factor, but showed larger variations across seasons. During the oligotrophic summer upwelling between 1 and 3 m depth can enrich surface waters by 100-200 mg DIN m-2 d-1. However, response to single upwelling events typically lasting few days only was difficult to capture, but areas characterised by upwelling consistently had the highest Chl-a a specific primary production. The importance of nutrients to variations in light-saturated production differed between areas and seasons, but overall DIN concentration was more important than PPR than phosphate, which was expected considering a very low N:P molar ratio of 1:2 lasting from May through September.

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FACTORS AFFECTING BROWN TIDE BLOOMS (Aureococcus anophagefferens) AND PRODUCTIVITY IN MID-ATLANTIC COASTAL LAGOONS

Between 2002 and 2007, we monitored blooms of Aureococcus anophagefferens in Chincoteague Bay, a mid-Atlantic coastal lagoon. In addition to an interannual comparison of nutrient dynamics between sites and years within Chincoteague Bay, we compared nutrient dynamics and productivity in nearby lagoons with shorter residence times that were impacted by blooms. Dissolved inorganic and organic nutrient concentrations, rates of nitrogen and carbon uptake, and the abundance of A. anophagefferens and co-occurring phytoplankton were compared over six years, five of which had significant bloom events. Results show that no single N source was the driver for blooms; both inorganic nitrogen (e.g., ammonium and nitrate) and organic nitrogen (e.g., dissolved free amino acids and urea) were taken up during Aureococcus anophagefferens blooms. In addition, both organic and inorganic carbon sources were assimilated by cells. Bicarbonate uptake usually dominated the carbon uptake during the daytime but there was substantial organic carbon uptake at night. In addition, organic carbon uptake appeared to increase as blooms progressed, likely due to light limitation from self-shading and/or depletion of dissolved inorganic carbon (pH became elevated during blooms). Using taxa-specific techniques, we observed that Aureococcus anophagefferens out-competed bacteria for organic nitrogen compounds including dissolved free amino acids during blooms but bacterial growth was stimulated by blooms with their abundance increasing during and after blooms. Since blooms have been recorded in Chincoteague Bay, dissolved organic carbon appears to have accumulated in this system over time and may ultimately lead to further impacts to the ecosystem.

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ESTUARIES PROGRAM: SPRING INTO ACTION TO EDUCATE TOMORROW’S LEADERS

The number of residents living in coastal areas around Florida has been increasing dramatically in recent years. This trend creates undue pressure on the local environment. Anthropogenic influences such as runoff, boat traffic, and other local land uses undoubtedly form the majority of this pressure. Educating the public about these issues has only recently become an increased priority. In the ESTUARIES Program at the Academy of Environmental Science research surrounds relationships between water quality and biotic factors such as plankton diversity and seagrass growth and distribution through hands-on labs, field research, socioscientific debates, and community workshops. This not only teaches students critical Marine Science, Chemistry, and Environmental Science concepts, it does so in a manner that is meaningful to their everyday lives through rigorous and relevant curriculum. These students can then contribute to the environmental literacy of the public through community workshops in which they step out of the role of student and into the role of teacher. Findings from this study have provided evidence that heavy anthropogenic runoff is having a negative impact on microscopic biota of the Crystal River.

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STRUCTURAL HETEROGENEITY IN SOURCE-SINK ESTUARINE COMMUNITIES

Community ecology focuses on understanding the mechanisms that drive patterns of diversity, with emphasis on conservation efforts that maintain species abundance and distribution. As habitats become fragmented or destroyed, the spatial distribution and physical characteristics of habitats will play an important role in community dynamics. Source-sink relationships are controlled by mechanisms that change based on the dispersal strategies of the individual species. A habitat may become a source or sink population based on the combination of abiotic factors and coexisting species. However, a community does not necessarily behave as a source or a sink for all the species present. The occurrence of multiple dispersal strategies and life histories within a community creates the opportunity for heterogeneity to drive species’ abundance patterns and alter species distribution. In the northern Gulf of Mexico, we explored the effects of structural heterogeneity on the diversity of shallow-water benthic species. PVC tiles were used to form 10x10 cm2 communities, and we used community age as a surrogate for the establishment of sources and sinks. Tiles were paired in close proximity at different levels of heterogeneity to drive patterns of diversity, with emphasis on conservation efforts that maintain species abundance and distribution. As habitats become fragmented or destroyed, the spatial distribution and physical characteristics of habitats will play an important role in community dynamics. Source-sink relationships are controlled by mechanisms that change based on the dispersal strategies of the individual species. A habitat may become a source or sink population based on the combination of abiotic factors and coexisting species. However, a community does not necessarily behave as a source or a sink for all the species present. The occurrence of multiple dispersal strategies and life histories within a community creates the opportunity for heterogeneity to drive species’ abundance patterns and alter species distribution. In the northern Gulf of Mexico, we explored the effects of structural heterogeneity on the diversity of shallow-water benthic species. PVC tiles were used to form 10x10 cm2 communities, and we used community age as a surrogate for the establishment of sources and sinks. Tiles were paired in close proximity at different levels of heterogeneity. Here, we report the response of populations’ sources and sinks to heterogeneity, and its effect on overall tile diversity.

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IMPACTS OF MERCENARIA MERCENARIA AQUACULTURE ON SEDIMENT AND WATER QUALITY: THE ROLE OF MACROALGAE

Aquaculture of the hard clam, Mercenaria mercenaria, in the Chesapeake Bay and coastal waters has significantly expanded in the past decade. Although often deemed less ecologically damaging than finfish culture due to its lack of reliance on artificial fish feed
and minimal use of invasive gear, the impacts of clam aquaculture on sediment and water quality are unknown. A group of Chesapeake Inlet, on the eastern side of Maryland, and DeSoto Peninsula, have reported significant macroalgal growth atop the anti-predator nets used to cover clam beds, suggesting a significant impact by clam aquaculture on nutrient dynamics. Macroalgae may serve as an ephemeral repository for nitrogen released by clams and microbial processing of biodeposits. Preliminary work in Chesapeake Inlet has demonstrated significant higher organic carbon and sediment porewater concentrations of DIN/P, DON, and sulfide in clam beds as compared to adjacent bare sediments. A Pilot in situ study in July, 2011 aimed to quantify and compare net community production and nutrient fluxes at clam beds and control sites. Treatments were designed to determine the importance of macroalgae as an ephemeral sink for ammonium and the contribution of clam and associated microbial processes to DIN fluxes. Cores inserted at random locations in clam beds, with nets removed, and bare sediments were incubated in the light and dark over 4-hours; macroalgae were added to half of the clam beds at culture densities. Measurements demonstrated the importance of macroalgae in reducing ammonium fluxes to the water column. Clam beds were net autotrophic in the presence of macroalgae and net heterotrophic in the absence of macroalgae, whereas bare sediments were net autotrophic. Further experiments are planned to study the role sediment microbial processes play in reducing versus retaining nitrogen in clam beds.

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LONG-TERM TRENDS IN CHESAPEAKE BAY SEASONAL HYPOXIA, STRATIFICATION, AND NUTRIENT LOADING

Recent results have shown a shift in the relationship between the winter/spring nitrogen loading into Chesapeake Bay and the hypoxic volume in July. In this study, we explored the hypothesis that this shift is the result of changes in Bay physical conditions by performing a detailed spatial and temporal analysis of dissolved oxygen, nutrient, and stratification-related data over 60 years. By analyzing oxygen observations throughout the entire year (as opposed to focusing solely on mid-summer), we discovered that there are major intra-summer differences in long-term hypoxic volume trends. In particular, early summer hypoxic volumes have increased substantially in recent decades, whereas late summer hypoxic volumes have slightly decreased in a manner that correlates well with nitrogen loads. Furthermore, the early summer increase in hypoxic volume can be explained by an increase in June water column stratification. Additional findings show that the duration of Bay hypoxia in summer is correlated with winter/spring nitrogen loads. Our findings confirm the detrimental role that excessive nutrient loads play in hypoxia, and reveal that the disconnect between long-term nitrogen loads and hypoxia in Chesapeake Bay is an early summer phenomenon likely due to increased stratification. Causes for the stratification trends are being explored and may relate to large-scale climatic changes.

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RESPONSE OF A NEARSHORE FISH COMMUNITY TO SHORELINE MODIFICATION, POTOMAC RIVER, MARYLAND

Coastal regions across North America and the world are experiencing accelerated rates of erosion through natural processes (storms, tides) and increasing sea levels possibly due to climate change. This is particularly evident on the low-lying shores of the Chesapeake Bay and its tributaries. In 2007-2009, the Navy constructed a series of sills and breakwaters in the Potomac River adjacent to Naval Support Facility Indian Head. As a component of this construction project, natural resource managers used the opportunity to support research into the effects of shoreline modification on nearshore aquatic communities. This study assess the effect of shoreline modification on nearshore fishereries using various metrics. To determine changes in the community we used a (B)efore (A)fter (C)ontrol (I)mpact design (BACI) to date collected seasonally (Spring, Early Summer, Later Summer, Fall) during 2006, 2009, 2010 with a 33 meter beach seine towed along six sites (4 control, 2 impact) in the tidal Potomac River. Once collected, we measured 10 (individuals per species), enumerated and weighed each sample, and entered data into an Access database. We then calculated a series of metrics (total abundance, total biomass, species occurrence, species diversity and richness, and catch per unit effort), and analyzed them using before-after (2006/2009, 2010), control/impact, yearly, seasonally, and by system (Potomac/Mattatomp) with Kruskal- Wallis and metric multiple regression and analysis of similarity. Results to date show a seasonal pattern typical of fisheries in the mid-Atlantic region. In addition, species richness was highly significantly different when comparing before and after modification and between years sampled, and total abundance, total biomass were moderately different comparing before/after and years sampled. Biomass was also moderately different using years sampled. Catch per unit effort also increased with years sampled.

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NITROGEN-FIXATION AND DENITRIFICATION ACTIVITY IN NARRAGANSETT BAY, RHODE ISLAND SALT MARSHES LOCATED ALONG A NUTRIENT CONCENTRATION GRADIENT

Salt marshes are critically important ecosystems that provide a unique habitat for a variety of terrestrial and marine species and provide essential ecosystem services including storm surge protection, nutrient cycling and pollution filtration. Salt marshes tend to play a large role in coastal nitrogen cycling, and with the potential to remove human-derived nitrogen that contributes to eutrophication, there has been much interest in better understanding nitrogen dynamics in salt marshes. We have been measuring the exchange of nitrogen between the marsh surface and the atmosphere in salt marshes located in Narragansett Bay, Rhode Island. Due to a long history of anthropogenic nitrogen inputs at the head of the bay and the resulting north-south gradient in nutrient concentrations, Narragansett Bay is an excellent location for investigating how nitrogen (N)-fixation and denitrification in marshes are affected by long-term eutrophication. During the summer of 2011, using intact marsh sediment cores incubated in vitro, we measured gross N-fixation using the rate of reduction of added acetylene (ARA) technique and gross denitrification using the isotope pairing technique (IPT) in marshes located along the north-south nutrient gradient in the bay. Our preliminary results show that N-fixation rates are higher in low load sites than high load sites with higher N-loads. In addition to measuring the response to eutrophication and the potential for the marshes to remove excess nitrogen, the study provides important baseline data useful for assessing future changes, including the effects of climate change and upcoming scheduled reductions in nitrogen levels at local wastewater treatment facilities.

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PRELIMINARY RESULTS OF A GROUND PENETRATING RADAR SURVEY AT THE MOUTH OF THE HARNEY RIVER, SOUTHWEST COASTAL REGION, EVERGLADES NATIONAL PARK, FLORIDA

The South Florida ecosystem has received national attention following the passage of the 1994 Everglades Forever Act. One goal of the U.S. Geological Survey’s research on the history of South Florida’s estuaries is to determine the nature of changes to the biotic and physical components of the system. The transitional zone between the terrestrial wetlands and the marine environment is particularly sensitive to changes in freshwater flow and sea-level rise, which can alter the biological and geomorphological makeup of the system. Reconnaissance of palo-environmental conditions is possible by analyzing the distribution and abundance of organisms preserved in sediment cores and understanding the geomorphology and transport of the sediments. The oyster, Crassostrea virginica, is considered one of the key indicator species for the region and large oyster beds along the southwest coast of Florida have contributed to the formation of islands. In order to understand the impact of altered flow and sea-level rise on the formation of oyster beds, it is important to understand their historical distribution. In an effort to locate Holocene oyster beds, surveys using a MALA 25MHz ground penetrating radar (GPR) instrument (modified for use in the marine/estuarine environment) were conducted along two transects at the mouth of the South Harney River. The two transect lines (each one kilometer long) were run heading out of the river into the Gulf of Mexico and perpendicular to the river respectively. Preliminary analyses of the transects indicate possible Holocene locations of oyster beds and channels from the river to the Gulf. The next step will be to confirm the results by probing for sediment changes and oyster beds in the locations indicated by the GPR data.

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LEARNING SCIENCE THROUGH RESEARCH

Recent studies have suggested that we, as a nation, are falling behind in science and mathematics, particularly at the upper levels of secondary education (TIMSS 2009). The rejuvenation of our education system in the fields of science, technology, engineering, and mathematics (STEM) is a priority in this country. Leaders in the science and education communities suggest that to initiate this reform, we must provide students with stimulating, hands-on activities that are research-based and that link our already world-class research in the diverse science disciplines to the classroom. The Learning Science through Research Project serves to enhance middle school science education by linking it with state-of-the-art research through a two-part program. The program’s professional development workshops for secondary science teachers provide background information on ocean sciences and related research. The program’s second component, the student lessons and field trips to our research laboratory, provides students with the opportunity to conduct experiments using first-rate instrumentation and technology. Each student learning activity consists of three parts: 1) preparation or pre-trip classroom activities, 2) action (field trip)
and 3) reflection (data analysis and interpretation and follow-up activities). We have developed nine Learning Science through Research programs for topics ranging from seagrasses to microbes and from ocean observing systems to dead zones. All topics are designed to meet classroom curricula needs and help student success on standardized tests. Over the past three years, 100 teachers have gained experience in ocean science research through the professional development workshops and over 2500 secondary students from local schools have participated in the program. We have featured the science of nine research faculty and provided teaching experience for twenty graduate students.

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AMPHIPOD CONTROL ON EPHYTITE LOAD AND THE CONCOMITANT EFFECTS ON SHOALGRASS HALODOLUE WRIGTHII BIOMASS

Small, mobile mesograzers are highly abundant in coastal waters and are crucial for transferring energy to higher trophic levels. In addition, mesograzers have the potential to offset the negative effects of nutrient addition in macroalgae and seagrass beds by controlling epiphyte growth. The role of small herbivores (such as amphipods, isopods, and small gastropods) is incompletely understood due to the practical difficulties of manipulating mesograzers abundance in field conditions using traditional cage exclusion. A novel method developed by Poore et al. (2009) uses rapidly degrading carbamate pesticide that allows in situ control of mesograzers abundance. Carbaryl pesticide was incorporated into slow-release plaster matrix blocks, which were used to exclude amphipod mesograzers from small plots. Using this method, we examined the top-down and bottom-up effects of amphipod abundance and nutrient addition on the growth of ephytites and the concomitant effects on shoalgrass, Halodule wrightii. Our experiment ran for ten weeks during summer 2010 in two shoalgrass beds in Big Lagoon, Florida, and changes in ephytite load were measured along with shoalgrass biomass, density, leaf length, and productivity. We found that the interaction among ephytite presence and nutrient addition significantly affected ephytite loads on shoalgrass (p<0.0036). Furthermore, we found significantly lower shoalgrass biomass when amphipods were absent (p=0.048). We believe that amphipod mesograzers may prove important in promoting seagrass health by ameliorating the increased stress caused by eutrophication.

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URBAN RUNOFF AND BACTERIOLOGICAL WATER QUALITY OF A CHESAPEAKE BAY SUB-ESTUARY

Our research seeks to evaluate the impact of an urban, multi-use neighborhood on the bacteriological quality of water in Knitting Mill Creek, a blind arm of the Lafayette River, a sub-estuary of the lower Chesapeake Bay. Since June 2009, we have taken weekly water samples for fecal-indicator bacteria, E. coli and enterococci, from two sites, a storm-sewer outfall and a nearby marina. Bacteriological analyses were performed using IDEXX products Colilert-18 and Enterolert, assays which yield most-probable-number estimates. In addition, we collected collateral information on temperature, salinity, and precipitation (a surrogate measure of urban runoff) and tested the hypothesis that abundances of fecal-indicator bacteria co-vary with these environmental parameters. None of the parameters proved to be strong predictors of bacterial concentrations. During five days of heavy, extended rainfall, however, there was a positive association of bacterial counts with the amount of precipitation. Other sources of contamination to the creek may include leakage from failing sewers, illegal discharge from continuously moored boats, and wildlife, especially ducks and geese. To distinguish among these possibilities, samples for source-tracking analysis will be taken in spring and summer 2011.

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OIL POLLUTION IN MANGROVES

The effects of bunker fuel oil on morphological and physiological responses of the mangroves, Avicennia marina and Bruguiera gymnorrhiza, were investigated in glasshouse and field experiments. In the glasshouse study, 15-month-old seedlings of A. marina were subjected to oiling or debarking treatments for 6 months. Oiling or debarking of a 5 cm ring of the basal portion of the stem, alone and in combination, reduced leaf CO2 exchange by over 50%, and resulted in the production of adventitious roots immediately above the base of the stem. Adventitious root production at the base of the stem may be a useful biological indicator of oil or other toxic pollutants in A. marina.

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GENETIC MONITORING OF THE EFFECTS OF THE DEEPWATER HORIZON OIL SPILL ON AN ECOLOGICALLY AND COMMERCIALLY IMPORTANT INDICATOR SPECIES, THE EASTERN OYSTER, ALONG ITS GULF COAST RANGE

The long-term effects of the Deepwater Horizon oil spill are still unknown, though it will likely take years to assess the impact on both pelagic and coastal organisms. For species like the Eastern oyster, Crassostrea virginica, exposure to oil on- and offshore poses a real threat to successive generations of this commercially important species. Not only do oysters generate over $100 million in commercial fisheries throughout the U.S. each year, but these filter-feeders provide valuable ecological services by controlling algal blooms, decreasing sediment and nutrient loads, and improving overall water quality. Because of their economic importance, and their direct and indirect effects on local biodiversity, population dynamics, food webs and nutrient cycling in coastal marine habitats, Eastern oysters are a proxy for the overall health of the Gulf coast region. To assess the effects of the spill on C. virginica and monitor change in important population parameters, we are using genetic methods to characterize levels of population differentiation, genetic diversity, and effective population size. We have genotyped over 700 adult oysters collected in Fall 2010 across 16 sites from south Florida to Texas to 1) compare levels of diversity and connectivity between areas that experienced heavy oiling and those that did not, and 2) initiate long-term genetic monitoring throughout the Gulf and assess recovery in affected C. virginica populations.

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POLICY IN PLANNING AN INTERNATIONAL NETWORK OF MARINE PROTECTED AREAS

Coupling human ecology with ecosystem-based management is critical for successful regional ocean governance, particularly in multinational areas. Coastal and marine spatial planning in international regions, such as the Gulf of Mexico, cannot be effective without reflecting each nation’s cultural priorities, which influence legal systems and, therefore, national ocean policies. The United States, Mexico, and Cuba - the three nations bordering the Gulf of Mexico - have disparate cultures, as evidenced by each nation’s history, politics, religion, and socioeconomics. Despite cultural and legal differences, the Gulf-bordering nations share the benefits of sustainably managed transboundary living marine resources. As a means to ensure the sustainability of transboundary populations, this research focuses on developing an ecology-based policy tool to facilitate the design of an international network of marine protected areas (MPAs) in the Gulf region. The premise is that cohesive regional ocean governance can be accomplished by weaving together scientific knowledge and pieces of existing statutory authority to protect the cultural and ecological fabric that relies on sustainable living marine resources. Therefore, a major component of this project is a compatibility analysis of existing national marine policies and international policy that are relevant to the creation of a network of MPAs in the Gulf of Mexico. This analysis would facilitate strengthening of network design parameters for consideration within existing legal frameworks by policy decision-makers from the United States, Mexico, and Cuba.

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CONSIDERATIONS IN THE USE OF HIGH RESOLUTION, LOW-ALTITUDE AERIAL PHOTOGRAPHY FOR COASTAL WETLAND RESTORATION

Effective assessment of the success of a coastal wetland restoration project requires a solid pre and post restoration monitoring program and comparison to a reference condition. Low altitude aerial photography (helium balloon and camera system) can provide high resolution digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization. The current practice of surveying vegetation at specific points along a transect is time consuming and fails to capture change that occurs in areas outside of these specific points. This is very important when trying to capture change overtime at a restored site. Digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization can provide high resolution digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization. The current practice of surveying vegetation at specific points along a transect is time consuming and fails to capture change that occurs in areas outside of these specific points. This is very important when trying to capture change overtime at a restored site. Digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization can provide high resolution digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization.

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AERIAL PHOTOGRAPHY FOR COASTAL WETLAND RESTORATION

Another alternative would be low altitude plane flights, but this option is cost prohibitive for most projects. This is very important when trying to capture change overtime at a restored site. Digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization can provide high resolution digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization. The current practice of surveying vegetation at specific points along a transect is time consuming and fails to capture change that occurs in areas outside of these specific points. This is very important when trying to capture change overtime at a restored site. Digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization can provide high resolution digital imagery to track changes in landscape level morphological conditions and vegetation re-colonization.
accurately cost each mission depending on the area and spatial configuration of the marsh body.

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STRUCTURED DECISION-MAKING AS A FRAMEWORK FOR DESIGN OF REGIONAL SALT MARSH MONITORING

Most salt marshes in the U.S. have been degraded by human activities, and threats from physical alterations, surrounding land-use, species invasions, and global climate change persist. Various management practices are employed to restore and enhance marsh integrity and ensure ecosystem sustainability. Choosing among management options requires scientifically-based methods for assessing marsh condition. Monitoring is integral to structured decision-making (SDM), a formal process for decomposing a decision into its essential elements. Within a natural resource context, SDM involves identifying management objectives, alternative management actions, and expected management outcomes. The core of SDM is a set of criteria for measuring system performance and evaluating management responses. Therefore, use of SDM to frame natural resource decisions leads to logical selection of monitoring attributes that are linked explicitly to management needs. We used SDM to guide selection of variables for monitoring the ecological integrity of salt marshes within the National Wildlife Refuge System (NWRs) in the northeastern U.S. Our objectives were to identify indicators of salt marsh integrity that are effective across large geographic regions, responsive to a wide range of threats, and feasible to implement within funding and staffing constraints of the NWRs. We engaged interdisciplinary experts to define the essential elements of salt marsh management decisions on refuges from Maine to Virginia. Through this process we identified attributes for monitoring salt marsh ecosystems that are integrated into conservation practice. In partnership with NWRs biologists, we then tested different methods for measuring these attributes on nine coastal refuges in the northeastern U.S. We based all field tests on existing protocols for salt marsh assessment. The result is a suite of monitoring metrics that targets NWRs management decisions and is practicable for implementing on a regional scale.

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REALISM, IMPLEMENTATION, CLIMATE CHANGE, AND COASTAL WETLAND ECOSYSTEM SERVICES

Although we understand the importance of the ecosystem services provided by coastal wetlands, this information often does not translate into implementation of policies and practices. In this presentation, I will share results from a series of interviews with people from governmental, non-profit, academic, and private institutions. The implementation of climate change adaptation along coasts will be used as a means to discuss how SDM and policies are made, applied, and evaluated at local, state, and national scales. I will also discuss selected case studies of on-the-ground adaptation and ecosystem service valuation. Implementation is often hindered by our inability to place our efforts within a broad context, including the social, economic, and political forces that are beyond our scope and control. A shared community vision of a positive future of environmental security may be essential. Uncertainty, risk, negativity, and complexity are not well-accepted by the public. Moral and logical imperatives often do not result in societal change; rather, individuals often do what they think others are doing. Definitions of adaptation are well-refined; it is more difficult to define and ensure ecosystem sustainability.

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VITAL SIGNS MONITORING OF ESTUARINE CONDITIONS OVER MULTIPLE SCALES AT THREE VIRGINIA NATIONAL PARKS IN THE NATIONAL PARK SERVICE NORTHEAST COASTAL AND BARRIER NETWORK

Estuaries in the northeastern U.S. are particularly threatened by human disturbances within the densely populated coastal zone. Therefore, the integrated assessment of estuarine water quality conditions in the National Park Service Northeast Coastal and Barrier Network is being undertaken through monitoring selected vital signs of nutrient enrichment using a multiple scale approach, with consistent protocols applied across all parks. In Virginia and Maryland, three National Parks (Colonial National Historical Park, Assateague Island National Seashore, and George Washington Birthplace National Monument) are being monitored to determine whether nutrient conditions in park estuaries are increasing over time, and to assess how estuarine natural resources may be affected by changing nutrient inputs. These three parks represent a diversity of habitats within this geographic region that range from low-salinity estuarine areas to high-salinity coastal lagoon systems. A probability sampling design using a grid of tessellated hexagons as the basis for random site selection is used for spatial sampling of biennial and long-term change in the estuarine waters. Short-term continuous measurements of water quality are accomplished using deployed arrays of YSI sondes and LiCor PAR sensors. Seagrasses are monitored at the Assateague Island National Seashore using SeagrassNet protocols. Results so far have shown some distinct changes in seagrass habitats possibly reflecting annual differences in climatic conditions.

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MANGROVE ISLANDS DISAPPEAR FROM WHITESTONE BAY, EVERGLADES NATIONAL PARK

Between 1928 and 2004, 80 islands have disappeared from Whitestone Bay with numerous others diminishing in size. Using historic maps and aerial photographs (1928, 1940, 1952, 1964, 1987, & 2004), GIS, and visual confirmation, the mangrove islands identified on these maps and aerials were present in previous years and non-existent by 2004. Increased hurricane intensity and frequency and sea-level rise are believed to initiate the island-loss scenario, with mangrove mortality and destabilized sediments completing the cycle. The vanished islands were scattered throughout Whitestone Bay, with some located along the perimeter and others in open water, and varied in size from less than 200m2 to nearly 7000m2. Significant alereation to the shoreline of large islands (50,000m2 - 200 ha) was also evident. In several cases small passes opened on narrow peninsular features creating one or more islands, which are also disappearing. No new islands were identified as emerging from the bay bottom, but only forming by division from a larger island. The rate of sediment erosion seems to vary throughout time. Between 1928 and 1964, the rate of sediment erosion of a noted peninsula and three islands was moderate, yet increased in the period of 1987 to 2004. Sea-level rise and hurricanes may have encouraged this erosional variation. Understanding the cause of island loss in Whitestone Bay may assist in management and conservation efforts of the more than 60,000 ha of mangrove forest from Cape Romano to Cape Sable.

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TOC AS A REGIONAL SEDIMENT CONDITION INDICATOR: PARSING EFFECTS OF GRAIN SIZE AND ORGANIC CONTENT

Total organic carbon (TOC) content of sediments is often used as an indicator of benthic condition. Percent TOC is generally positively correlated with sediment percent fines. While some range from grain size may have impacts on benthic organisms independent of organic content, it is often not explicitly considered in calibrating a TOC indicator. The EPA National Coastal Assessment data (n=1172 sites) from the U.S. West Coast shows a significant positive relationship of TOC to percent fines at a regional scale. Using the NCA values of 2 and 5 % sediment TOC to represent fair and poor sediment condition, 97 and 11 sites were scored as fair and poor. The 95% CL from the regional regression relationship was used to calculate the residual expectation of TOC after accounting for grain size. This correction reduced the
count to an estimate of 15 fair and 8 poor sites, suggesting that the uncorrected TOC index will substantially overestimate potentially impacted sites. The regional correction will be compared to TOC – percent fines relationships from 8 west coast estuaries to determine whether it is appropriate at a within-estuary scale. A variety of approaches will be used to determine if the adjusted TOC indicator captures biotic responses.

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REFERENCE SITE SELECTION FOR WETLAND CONDITION ASSESSMENTS: INTEGRATING BEST PROFESSIONAL JUDGEMENT AND OBJECTIVE SELECTION CRITERIA

The National Wetlands Condition Assessment (NWCA), one of a series of environmental assessments being conducted by states, tribes, the U.S. Environmental Protection Agency, and other partners, surveyed over 900 wetland sites across the lower 48 states during Summer 2011. The NWCA is designed to assess ecological integrity at regional and national scales and identify and rank the stressors most commonly associated with poor conditions. As deviation from the reference condition may be used as a measure of the effect of stressors on the assessment area, the selection and evaluation of reference sites that represent the best attainable (or least disturbed) watershed condition, habitat structure, water quality and biological parameters are critical components of the NWCA assessment. Over 1000 handpicked candidate reference sites across six select coastal and inland wetland types were ultimately selected for the assessment. These candidate reference sites were critically evaluated with a set of explicit criteria, including a combination of ground reconnaissance, aerial photography interpretation, and soil and vegetation maps to yield 100 sites selected for reference site sampling. We discuss issues related to reference site selection process and present observations from reference sites in coastal wetland settings.

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MAPPING ECOSYSTEM SERVICES IN THE TAMPA, FL WATERSHED

As part of US EPA’s Ecosystem Services Research Program (ESRP), our purpose was to conduct a study to inventory, map, and value ecosystem services provided by the nation’s natural systems. The Tampa Bay watershed was selected as a demonstration project focused on quantifying the effects of human development on the production and delivery of key ecosystem services considered to be of high value in that region (e.g. nutrient processing, carbon sequestration, fishery production, water storage, flood attenuation, others). The specific objective here was to present results as several maps of the ecosystem services that are beneficial to sustaining or improving the human well-being throughout the Tampa watershed.

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ECOSYSTEM CARBON FIXATION REGULATED BY TIDAL FRESHWATER MARSH PLANT RESPONSES TO ENVIRONMENTAL DISTURBANCE

The combination of rising sea level and altered river discharge may result in saltwater intrusion and changes in hydroperiod in low salinity coastal wetlands. Since June 2008, in situ manipulations in a Zizaniopsis miliacea (giant cutgrass)-dominated tidal freshwater marsh in South Carolina have raised porewater salinities from freshwater to oligohaline levels and/or subtly increased the amount of water flowing through the system. In response to elevated salinity, gross ecosystem productivity (GEP) decreased by 26%, whereas altering the hydrology depressed GEP by 9%. To determine the mechanism(s) driving changes in plot-scale GEP, we are measuring plant community characteristics (e.g., species composition, density, biomass) and leaf-level photosynthesis at this site. Early in the 2011 growing season, species richness in the +salt plots was roughly 40% of that in the control and +fresh plots (5.8, 13.8, and 13.4 species per 61 x 61 cm plot, respectively). Nearly all species were present at lower densities, or were absent entirely, in the +salt plots. A notable exception is Z. miliacea, which was present at a higher density in the +salt plots (48 plants/m2) than in the control and +fresh plots (27-29 plants/m2). However, Z. miliacea plants in the +salt plots tended to be shorter than in the other treatments. Other measured species showed more robust growth (greater height, # leaves, and/or leaf size) in control vs. +fresh plots and were virtually absent in +salt plots. Leaf-level net photosynthesis rates for Peltandra virginica (arrow arum) were highest in control plots (11.6 mmol m-2 s-1), about 50% lower in +fresh plots (5.3 mmol m-2 s-1), and even lower in +salt plots (3.5 mmol m-2 s-1). Collectively, these data indicate that changes in plot-scale GEP in response to environmental change stressors are not due to a single mechanism but instead reflect changes in the characteristics of the aboveground plant community and internal biochemical pathways.

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LETHAL AND SUBLETHAL RESPONSES OF EUPHYNOPEUS DEPRESSUS TO THE WATER ACkommodATED FRACTION OF NUMBER 2 FUEL OIL

As coastal development increases, estuaries are experiencing an influx of anthropogenic materials to which organisms must adapt in order to maintain fitness. Benthic macrofauna have limited ability to avoid such material. The xanthid Euphyneus depressus is a ubiquitous, euryhaline species dominating intertidal and subtidal oyster reefs along the east coast of the United States through the Gulf of Mexico. Oyster reef inhabitants, such as E. depressus, have the potential to come in contact with number 2 fuel oil if it is present in an estuary. Expansion of development along the Florida coast will increase No. 2 fuel oil entering the estuary from a variety of sources including runoff from roads, aerosol deposition, boats, industrial effluents, and major spills. This results in additional stress on E. depressus and potential effects on physiological mechanisms including osmoregulation and oxygen consumption rate. In order to quantify the lethal and sublethal effects of No. 2 fuel oil on E. depressus, detrimental concentrations (48h-LC50 and LC10) of the water accommodated fraction (WAF) of No. 2 fuel oil were established and two physiological endpoints, osmoregulation and oxygen consumption rate, were measured at three different concentrations over a 48-h period. WAF was prepared according to CROSERF methods using 15% artificial seawater, and crabs were exposed in 250-ml glass vessels. The LC50 and LC10 were calculated by the Probit procedure. Exposure to WAF was expected to impair hyperosmoregulation capabilities and increase oxygen consumption rate in comparison to the control.

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INTEGRATING CONSERVATION BETWEEN LAND AND SEA: STRATEGIES FOR WEST COAST ESTUARIES

Estuaries are highly valuable systems that provide numerous ecosystem services upon which we depend. These attributes make the protection and restoration of estuaries a major priority for the conservation of biodiversity. Given the many similarities in estuaries’ basic ecology and in the threats they face, a coordinated effort to practice integrated land-sea conservation at multiple sites and on different scales is likely to prove more efficient than a site-by-site approach. Although there are a variety of sophisticated estuary conservation projects ongoing on the west coast, these projects are occurring largely independently. To address this, we: (1) developed a process-oriented conservation planning approach that focuses on land-sea linkages; (2) built a regional database and conducted a regional characterization to identify points of commonality and coordinate action; (3) conducted outreach to practitioners in estuaries throughout the region to exchange knowledge; and (4) developed a framework for grouping sites based on common characteristics to yield high-leverage, multi-site strategies which significantly advance estuary conservation on the West Coast. Armed with these analyses, TNC-CA will: (1) help develop an informed network of local practitioners, (2) establish stronger state and federal partnerships aimed at estuary conservation; (3) identify and conduct on-the-ground demonstration projects; (4) develop tools for groups to replicate and exportable; and (4) strategically engage with key resource users/stakeholders in uncommon dialogues.

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DIEL HYPOXIA RESPONSE TO RESIDENCE TIME MANIPULATION

We manipulated the residence time of a tidal creek in Elk Horn Slough, California by temporarily installing a weir to impound water at low tide. The retention of water in the tidal creek at low spring tides mimicked the retention of water during neap tides when the intertidal creek does not drain completely. In the undisturbed condition, severe nighttime hypoxia was limited to a few days during neap tide, whereas installation of the weir resulted in nightly hypoxia for a three week period. We compare the relative importance of
The results show that from low- to high-water discharge, bed material flux increases transport and channel morphology in a major coastal river approaching its outlet. Field

**IMPLICATIONS FOR DELTA GROWTH AND COASTLINE MANAGEMENT**

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USE OF OTOLITH MICROCHEMISTRY TO ESTABLISH FRESHWATER RESIDENCY PATTERNS OF SOUTHERN FLOUNDER (PARALICHTHYS LESTHISTOGMA) ON THE GULF COAST OF TEXAS

Previous research, conducted in North Carolina and the northern Gulf of Mexico, has established that there is extensive use of freshwater habitat by juvenile southern flounder (Paralichthys lethostigma). Juvenile southern flounder have been collected at salinities below 10 ppt in Aransas Bay, suggesting that southern flounder in Texas might also utilize freshwater habitat. However, considering the dynamic climate of south Texas and the fact that southern flounder in Texas have been shown to have significant genetic and physiological differences from their congeners in other regions, the importance of freshwater habitat to juvenile southern flounder in Texas must be established. Patterns of freshwater residence will be determined using otolith microchemistry by analyzing stable isotope (87Sr/86Sr) and trace element (Sr/Ca, Ba/Ca) ratios to determine movements across salinity boundaries. In order for trace elemental analyses to be performed on otoliths, the trace elemental concentration of tributaries to the area must first be established. Water samples collected in the summer of 2010 from the major tributaries to the Aransas, Copano, San Antonio, and Mission Bay systems indicate that 8180 and trace element (Sr/Ca and Ba/Ca) values show significant variation among locations. These results indicate that if southern flounder in Texas do exhibit a freshwater residency period, it should be possible to assign an individual fish to a particular freshwater habitat. This will work provides fisheries managers with a more informed understanding of habitat requirements of juvenile southern flounder, leading to the implementation of more comprehensive and effective conservation and management strategies.

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Sediment Transport in the Lowermost Mississippi River: Implications for Delta Growth and Coastline Management

This study examines the importance of gradually varied flow conditions on sediment transport and channel morphology in a major coastal river approaching its outlet. Field measurements from the Mississippi River outlet are coupled with semi-empirical, physically based models to estimate bed-material sediment transport and associated transport stress. The results show that from low- to high-water discharge, bed material flux increases 10x and skin-friction shear stress increases 10x. We show that this significant temporal adjustment arises due to a backwater hydrodynamic condition that occurs in the lower 600 km of the Mississippi River. In order to predict how the transition from normal flow to backwater flow affects the time and space properties of sediment flux, we developed a simple model that estimates water-flow velocity and bed-material transport over the lower 800 km of the Mississippi River. Channel transect measurements are used to determine the cross-sectional area of water flow, local flow velocity, and skin-friction shear stress for low- to high-water discharge. Skin-friction shear stress values are then used to calculate bed-material transport. Our results demonstrate that during low- and moderate-water discharge, there is a downstream decrease in water-flow velocity and bed-material transport through the backwater segment of the Mississippi River. During high-water discharge the trend is reversed and there is a downstream increase in water velocity and bed-material transport. By conserving sediment mass over an average annual hydrograph we show that the spatial trends in bed-material flux promote a tendency for channel-bed aggradation in the upper reaches of the backwater segment (150-600 kilometers above the outlet) and a region of channel-bed erosion in the final 150 kilometers of the Mississippi River. The implications of these results for river-channel morphology and coastal rebuilding efforts in Louisiana will be explored in detail.

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Restoring Oyster Reefs in the Northern Gulf of Mexico: Socioeconomic and Geo-Political Factors Affect Restoration Opportunities

Once a dominant feature of estuaries worldwide, oyster reefs have recently been identified as one of the most endangered coastal ecosystems, fueling significant efforts to restore and enhance these systems. Oyster reefs located in the northern Gulf of Mexico have been identified as some of the healthiest of reefs globally, and current efforts focus on devising an approach to coastwide restoration and protection of these reefs. As with all natural resource management and restoration, success is dependent on more than simply understanding the biological requirements of the resource; rather, they are equally dependent on understanding and working within the social and political context in which these management and restoration activities must occur. To better understand the context in which Gulf-wide reef restoration must operate, we report on the results of a survey of over 2000 key stakeholders representing 6 interest groups (oyster growers, oyster harvesters, recreational fishermen, environmental organization members, scientific researchers and regulatory agency employees) from the five Gulf states (Texas, Louisiana, Mississippi, Alabama, Florida). The objectives of the survey were to determine 1) knowledge of, and values placed on oyster reef ecological services, 2) support for different methods of oyster reef restoration, 3) perception of obstacles, trade-offs and benefits of different reef restoration approaches, and 4) preference for oyster reef restoration implementation and management. These results only inform oyster reef restoration planners of the constraints and opportunities of a regional or estuary specific plan in the Gulf of Mexico up front, but can help guide their restoration actions more efficiently and effectively, enabling them to achieve their desired outcomes.

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Nutrient Enrichment and pH Perturbations in a Phytoplankton-Based Coastal Marine Ecosystem

While growing concern about ocean acidification due to rising carbon dioxide in the atmosphere is relatively recent, estuaries and other coastal systems may have experienced much larger previous perturbations of pH. These could have resulted from organic loading associated with land clearing, organic loading in urban estuaries from water and sewer systems, the runoff of acid rain in low salinity tributaries, and nutrient enrichment from sewage, fertilizer runoff, and nitrogen enriched atmospheric deposition. Nutrient enrichment may be particularly pernicious since N and P often cycle through inorganic and organic forms many times as they pass through an estuary and thus amplify total system metabolism (with attendant CO2 production and consumption) over wide areas. Here we report the results of a multi-year fertilization experiment using large (13 m3, 5 m deep), phytoplankton-based, coupled water column and benthos mesocosms at the Marine Ecosystems Research Laboratory (MERL). The mesocosms were vertically mixed and averaged about 30 psu with little seasonal variation. Water temperatures ranged from about 1 to 20°C. The flux of carbon dioxide across the air-water interface was sufficiently slow even in these well-mixed tanks that the amplitude of the seasonal cycle in pH (maximum in late winter, minimum in mid summer) was markedly enhanced by fertilization. While triplicate unmitigated controls showed an annual range of 7.6 to 8.5, a doubling of background nutrient inputs increased this range to 7.5 to 8.9. Another doubling of nutrient input increased the annual maximum pH to 9.2 but did not further reduce the minimum. The non-intuitive greater sensitivity of the upper pH range is due to the strongly non-linear relationship between aqueous or free carbon dioxide and pH. The annual excursion of pH in 2016 was predicted for that environment out to 2100.
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AN ASSESSMENT OF COASTAL AND ESTUARINE HABITAT IN SUPPORT OF THE NATIONAL FISH HABITAT ACTION PLAN

The first national assessment of estuarine habitat was recently completed to support the National Fish Habitat Action Plan. A quantitative assessment of habitat components was nested into a multi-scale spatial framework for the coastal Atlantic, Pacific, and Gulf of Mexico using NOAA’s Coastal Assessment Framework (CAF). Indicator values representing known threats to aquatic habitat were assigned to 219 estuaries nationwide using the CAF. Indicators were summarized as four component disturbance indices: watershed and shoreline land cover, pollutants, alterations to discharge, and eutrophication. The indicator values can be used to identify specific threats to aquatic habitats and ecosystems. Indicators were summarized as a Composite Disturbance Index, representing a nationally standardized metric of habitat disturbances to estuaries. The results of the assessment can be used by estuarine scientists and managers to improve understanding of the processes affecting estuaries as well as guiding restoration and conservation activities. Next steps for research include testing how these scores predict fish species composition and abundance metrics of well-studied stocks. Additional analyses within regions will be completed to further refine habitat conditions and assist in establishing critically degraded areas. Assessments of Alaska and Hawaii’s coastal and nearshore habitats will be completed following these methods as available data allows.

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SIMULATING THE DISPERAL OF AGING OIL FROM THE DEEPWATER HORIZON SPILL WITH A LAGRANGIAN APPROACH

The objective of our program is to investigate the subsurface and surface dispersal of different size classes of oil released from the Deepwater Horizon well. We use a new version of the open-source Lagrangian transport model LTRANS which simulates the trajectories of oil droplets as they age over time. This Lagrangian approach incorporates the effects of differences in initial droplet characteristics as well as time-varying droplet behavior. Hydrodynamic predictions were provided by SABGOM, a ROMS-based South Atlantic Bight and Gulf of Mexico circulation model, and initial droplet distributions were determined by multi-phase plume modeling. We ran the SABGOM/LTRANS model system for the time period of the Deepwater Horizon oil spill. Results compare favorably with observations of a subsurface plume made by Camilli et al. (2010). Model sensitivity studies indicate that oil droplets with diameters greater than 100 microns rise quickly to the surface. Droplets with diameters of 50 microns or less have subsurface dispersal trajectories, and droplets10 micron in diameter or less have behaviors similar to passive particles. Degradation rates of oil droplet diameters had a marked influence on oil dispersal and oil droplets10 micron in diameter or less have behaviors similar to passive particles. Indicators were summarized as a Composite Disturbance Index, representing a nationally standardized metric of habitat disturbances to estuaries. The results of the assessment can be used by estuarine scientists and managers to improve understanding of the processes affecting estuaries as well as guiding restoration and conservation activities. Next steps for research include testing how these scores predict fish species composition and abundance metrics of well-studied stocks. Additional analyses within regions will be completed to further refine habitat conditions and assist in establishing critically degraded areas. Assessments of Alaska and Hawaii’s coastal and nearshore habitats will be completed following these methods as available data allows.

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SUCCESS OF SEAGRASS RESTORATION IN PENSACOLA BAY, 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. Previous research has investigated nutrient concentrations in the overlying water associated with seagrass beds and pore water nutrient concentrations within seagrass beds dominated by calcium carbonate rich sediments. 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. Light availability and nutrient levels in the water column as well as pore water nutrient levels and sulfide were measured monthly from March 2010 to April 2011 at 4 locations within the Pensacola Bay system. Pore water was extracted from Escambia Bay, East Bay, Pensacola Bay, and Big Lagoon and analyzed for NH4+, sulfide, and DIP. We also measured water column nutrients including NO3-, NH4+ and DIP, temperature, salinity, pH, dissolved oxygen, light profiles, epiphyte coverage, and chlorophyll a concentrations. Pore water nutrients were usually much higher in the transplanted and naturally vegetated areas compared to bare sediments at all locations. In addition, pore water N/P ratios show little evidence of either N or P limitation. Sulfide levels within a salt marsh inlet of Pensacola Bay and in Big Lagoon were higher than the same areas of Escambia and East Bays reaching over 2000 μM during September 2010. While the percent irradiance reaching the bottom usually exceeded 30% of surface irradiance, epiphyte loads on leaves was high, usually exceeding 0.5 μg chla/cm2. In the future, these techniques could be applied to other regions as an assessment for the potential of seagrass recovery.
DETECTING CHANGES IN HYPOXIA USING IIOOS BUOYS AND NEP SURVEYS

Extensive areas of the bottom waters of western Long Island Sound experience periods of low dissolved oxygen concentration in the summer. To reduce the duration and extent of hypoxia, a plan for reducing the discharges of nitrogen has been implemented by New York and Connecticut and an EPA supported long-term ship monitoring program has been established. Recent observation by IIOOS buoy mounted instruments have revealed substantial variability at tidal and weather band frequencies in the concentration of dissolved oxygen, temperature and salinity. We report the magnitude and seasonal evolution of this variability at five sites in the area prone to hypoxia. Since the ship surveys alias these high frequency fluctuations, we estimate the resulting errors in estimates of the hypoxic area and duration using Monte-Carlo simulation. We find the errors to be comparable to the variation in the record and identify the years that are significantly different. We also compare duration of hypoxia estimates from the ship surveys to those obtained from buoy measurements and show that the buoy products are more precise.

Changes due to management actions will be detectable in moored measurements first.

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INTERTIDAL ENERGY AND SEDIMENTATION IN THE BAY OF FUNDY, NOVA SCOTIA, CANADA

Due to a renewed interest in tidal power research and the potential installation of generators in the Bay of Fundy, a need has developed for localized, high-resolution studies of estuarine processes and the far-field effects of energy extraction. The purpose of this research was to improve our understanding of the natural variability in energy in the Upper Bay of Fundy through investigation of hydrodynamic and sedimentary processes over spring-neap tidal cycles. Studies were conducted within a confined terminal creek (2009) and an exposed salt marsh and mudflat (2010) over a wide range of tidal conditions. Field measurements of current velocity and suspended sediment concentration were made using acoustic Doppler velocimeters (ADV), an acoustick Doppler current profiler (ADCP) and optical backscatter sensors (OBS). Additional variables collected include sediment deposition, wave activity, detailed topographic surveys and meteorological conditions. ADV data indicate that in the confined tidal creek, tides that surpassed bankfull level showed a generally even distribution of tidal energy, while tides that remained below bankfull showed strong flood dominance. Maximum current velocities ranged from 10 cm/s to 20 cm/s in the creek thalweg, and up to 30 cm/s on the creek bank. Velocities at the exposed site were marginally slower, consistently between 5 and 15 cm/s, with minimal variation over flood and ebb phases. More sediment was deposited within the tidal creek during spring and transitional tides opposed to neap tides, however, neap tides were found to contribute more material to the surface at the exposed salt marsh and mudflat site, compared with both spring and transitional tidal cycles. These data will be applied to sediment transport models being developed to assess the potential far-field environmental effects of tidal power activities.

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THE PENVOSB CT ESTUARINE FISH COMMUNITY AND ECOSYSTEM SURVEY

Biologists need to develop less obstructive, fishery-independent, and cost-effective methods to quantify changes in estuarine fish distributions particularly where endangered species occur. In Maine, US, the Penobscot Estuarine Fish Community and Ecosystem Survey is developing methods to describe the spatial and temporal distribution of fish and reduce sampling bias. Our work integrates fish capture techniques with hydroacoustics to develop an index of fish biomass, size distribution and species composition to monitor changes over time. The project began with an initial exploratory and descriptive phase and is evolving into a study network where long-term monitoring, hypothesis testing, and impact assessment can be conducted in the future. The Penobscot system also allows us to monitor estuarine responses to a major upstream river restoration project (multiple dam removals). The feasibility studies that began in 2010 will continue in 2011-12 and include surveys that use capture techniques including beach seining, fyke netting and trawling, and we will integrate these techniques with hydroacoustic methods. Initial survey results found seasonal evidence of natural reproduction of American shad (Alosa sapidissima), previously undocumented in the Penobscot River. The temporal distribution of shad juveniles suggests spawning in the Penobscot River may occur over 3-4 months. The presence of juvenile bluefish (Pomatomus saltatrix) and rough scad (Trachurus lathami), species with a more southerly distribution, was detected and will be monitored over time to detect patterns consistent with range shifts. Knowledge gained from this study will improve our ability to: 1) manage estuaries in the future and 2) conduct vital research on the habitats and ecosystem services they provide. The design specifications should be transferable to multiple systems to get a regional perspective.

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SPATIAL AND TEMPORAL VARIATION IN MACROALGAE δ15N VALUES FROM A HIGHLY IMPACTED COASTAL LAGOON IN THE GULF OF CALIFORNIA

Elevated nitrogen (N) loads from anthropogenic activities are causing eutrophication in coastal ecosystems around the world. Mexican coastal ecosystems are not the exception. In Urras lagoon (SE Gulf of California), multiple sources of N are altering the biogeochemical cycle of N and its ecological functioning. In order to assessing the ecological effects of N in coastal waters, we consider important the identification of N sources and to trace it in the ecosystem. In this study, we used macroalgae as bio-monitors that register and integrate the variability of N. Macroalgae is sufficiently sensitive to register changes in concentrations of dissolved N in water column and of their stable isotopes and may provide time-integrated information on N pollution. Each month during a whole year (February 2009 to March 2010), over 650 samples of macroalgae were collected to study the N isotopic signals. Water chemistry parameters were measured in situ and in the laboratory including all forms of reactive N. Total dissolved N varied from 3.7±28.2 μM in rainy season 2009 to 59±96.9 μM in winter 2010. Ammonia varied from 3.1±2.1 to 5.4±5.9 μM in hot and cold dry seasons, respectively. Nitrates varied from 4.6±4.2 μM to 8.4±6.3 μM during dry season. Hydrography and water chemistry changes directly affected the composition and distribution of macroalgae. Values of δ15N (‰) in most common species (global average along lagoon and around the world) were 14.3±3.4 for Ulva intestinalis, 8.9±4.1 for Caulerpa (Caulerpa lentilloroides, 13.0±3.4 for Gracilaria vermiculophylla and 14.3±7.2 for U. expansa). Overall, significant differences were observed among macroalgae habitat and climate season for same species, and differences between different macroalgae species for same habitat and/or seasons. In order to correct interpretation of isotopic N signals in macroalgae from highly urbanized subtropical coastal lagoon, the high spatial and temporal variability need to be considered.

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CLIMATE CHANGE AND EXTREME WEATHER IMPACTS ON SALT MARSH PLANTS

Regional assessments of climate change impacts on New England demonstrate a clear rise in rainfall over the past century. The number of extreme precipitation events (i.e., two or more inches of rain falling during a 48-hour period) has also increased over the past few decades. As part of a larger effort to examine the interacting hydrologic effects of increasing rainfall, extreme storms, and sea level rise on marsh plants (Spartina alterniflora and Typha angustifolia), we conducted mesocosm experiments to consider how efficiently nitrogen (N) in the rain is being retained by cord grass and cattails at various positions in the marsh. By adding a nitrogen stable isotope tracer to the rainfall treatments (ambient and extreme), we quantified the N allocation and retention for plants receiving different pulses of rain at different positions in the salt marsh. Our hypothesis is that the vegetation will be less effective at retaining N delivered via extreme rains as there is less time for uptake and transpiration. We provide preliminary evidence for how the nitrogen balance of salt marshes will respond to the effects of sea-level rise and rainier weather associated with climate change.

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EVALUATING AND MITIGATING INVASION RISK POSED BY SALTWATER AQUARIUM STRAINS OF THE MACROALGAL GENUS CHAETOMORPHA

Aquarium release threatens the ecological integrity of aquatic systems as a vector for introducing non-native species. Following coastal invasions by released aquarium strains of Caulerpa taxifolia, aquarists began using the macroalgal genus Chaetomorpha. Use of “chaeto” now exceeds 50% of aquarium hobbyists surveyed. We thus sought to determine its invasion potential and to mitigate those risks. We tested factors that promote invasion success, fragmentation and genetic diversity, in chaeto purchased from online and local
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BIOMASS AND PRODUCTION OF SUB-ARCTIC EELGRASS (ZOSTERRA MARINA) MEADOWS IN GREENLAND

We studied the biomass and production of four eelgrass populations in Godthåsfjorden, Greenland (64°N), near the northern distribution limit of the species. Here, eelgrass is confined to small, geographically isolated (~80 km apart) populations in the inner part of the fjord system, where summer water temperatures (13-15°C) are higher than in the outer part (9°C). Historic records dating back to 1830 indicate that the current distribution of eelgrass has changed very little over the past nearly 200 years. The studied populations were dense (860 – 2046 shoots m-2) and the aboveground biomass was relatively high (90 – 486 g dw m-2) and comparable to that reported for eelgrass beds elsewhere. Flowering shoots with initial anthesis occurred at the time of sampling (mid-August), but we found no seeds or seedlings growing on the bare sediments. Sequences of intermodal rhizome lengths demonstrated a clear annual cycle with an annual production rate of 6.9 –13.1 leaves per shoot. This is considerably lower than leaf production rates reported for temperate eelgrass stands, and indicates that the Greenland populations are under physiological stress caused by low temperatures and short growing season. The average annual rhizome extension varied between 7.2 and 28.8 cm per year, comparable to rates in more southern populations. The combination of a relatively high standing leaf biomass and a moderate annual leaf production lead to a slow turnover of leaves (1.6 – 2.6 year) and leaves and their nutrient content in sub-arctic populations are thus 2 to 3 fold lower than in eelgrass populations growing at lower latitudes. The results suggest that the expected temperature increase of surface waters may enhance biomass production and a wider distribution of eelgrass because more areas become available for eelgrass colonization along the sub-arctic coasts of Greenland.

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THE CONDITION OF SCLERACTINIAN CORALS AND ASSOCIATED REEF FAUNA IN LA PARGUERA, PUERTO RICO

Scleractinian corals, octocorals, sponges, fishes, and foraminifera were assessed at 24 sites near La Parguera, Puerto Rico in fall 2008. Sites were selected to coincide with locations sampled by NOAA in 2005 for sediment contaminants. Our goals were to evaluate the sensitivity of coral reef condition indicators and patterns in coral reef community metrics (e.g., species abundance, surface area (SA), biomass) across a known low-level sediment contaminant gradient. NOAA’s sediment contaminant data were used to generate categorical scores for each proximal study site. These scores were evaluated for associations with coral reef metrics as well as other potential predictors of reef condition (e.g. distance from shore). In comparison to results from previous studies in which lower taxonomic richness was associated with higher contaminant levels, both stony coral taxon richness and indicators that incorporated stony coral SA tended to be higher at sites with high sediment contaminants. Potential impact from contaminants was reflected only in the sediment-dwelling foraminifera, for which a Foramin Index (FI) significantly and negatively correlated with contaminant scores. Lower FI scores are associated with impaired water quality and a community shift from larger symbiotic forms to smaller, stress-tolerant forms. Sites located further from shore also had higher FI scores, perhaps reflecting diminished land surface runoff and associated sediments, nutrients and pollution. Measures of coral and sponge SA provides a means for quantifying structure and habitat provision to other reef organisms. Stony corals constituted the majority of total reef SA at over half the sites, while octocoral SA ranged from 7-78% of total. Sponges contribution to total SA was lowest, only exceeding 10% of total SA at one site. Surface rugosity was correlated positively with stony coral SA but not with fish abundance or species richness. Our results are compared with other studies of reef health in the region.

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A BAY OF FUNDY SALT MARSH RESTORATION AT AULAC, NB, CANADA - THE FIRST YEAR

The purpose of this presentation is to report on the progress of a salt marsh restoration at a site near Aulac, NB in the Cumberland Basin of the Bay of Fundy. Cumberland Basin is a 118 km square turbid estuary with a semi-diurnal tidal range of 10 to 13 metres. The fetch ranges from 5 to 20 km and the water has a high suspended sediment concentration (mean > 300 mg L-1). The project was designed in 2005 and implemented in 2010. Three openings were cut in an existing dyke at the site in October 2010. As a result of this action,
two different agricultural fields are now being regularly flooded with salt water from the Bay of Fundy. Field data were collected prior to construction for a number of environmental variables (e.g., existing vegetation) and marker horizons were installed. Since the openings were constructed, they have been mapped using ground-based laser scanning (LiDAR), flows through one of the openings were measured using an acoustic Doppler current profiler (ADCP), and water levels both inside and outside of the restoration cells have been measured. In the summer of 2011, sediment deposition over the marker horizons was measured for the first time using cryogenic coring. Measured sediment depth and spatial patterns were then compared to predicted sediment depth and spatial patterns from the design process. Finally, the initial success of the project is assessed.

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ENHANCING CLIMATE OUTREACH IN COASTAL AREAS OF THE U.S. SOUTHEAST AND CARIBBEAN

Outreach and extension professionals in coastal areas of the US southeast and Caribbean interact with a broad range of stakeholders that are likely to be affected by climate change impacts. During a workshop in 2010, professionals shared information about attitudes and concerns of their stakeholders and their own needs for tools and information to better prepare their stakeholders for addressing climate change. The participants identified their stakeholders as local, county and state governments; transportation, water and power utilities; businesses; educators; and organizations representing interests as diverse as fishermen, home owners, businesses, and conservation. Climate impacts of greatest concern to these audiences was flooding, due to increased rainfall, inundation, and sea level rise, and the impacts of such elevated water levels on infrastructure, shorelines, and natural systems, especially during storms. The ability to plan for such impacts was deemed a high priority. Barriers to educating constituents included the diversity of audiences and their specific information needs, the amount and complexity of information on climate change, and the views of some stakeholders toward climate change. Barriers to stakeholders acting on climate change included the magnitude of the problem, trusting information sources, the time frame to see impacts occur, costs of taking action, and political will. Participants identified means to improve climate outreach in the region including better understanding the audiences, improving the content and consistency of the message, being locally relevant, enhancing the tools and materials available to practitioners, and building a community of practice to share knowledge and better coordinate approaches. Among the tools and resources identified, the most important were consistent messaging from authorities, tools to visualize sea level change and inundation, specific actions for communities to take, and an expertise directory.

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SUBMERGED AQUATIC VEGETATION IN THE CALOOSAHATCHEE RIVER ESTUARY: THE EFFECT OF BOTH NATURAL AND ANTHROPOGENIC FRESHWATER INFLOW

Submerged Aquatic Vegetation (SAV) plays an important part in the health and well-being of aquatic ecosystems whether it be as a nutrient filter, as habitat, or as a feeding or nursery ground for commercially valuable aquatic species. Knowing the distribution and trends of SAV and how freshwater input (both natural and managed) can affect these trends can aid coastal resource managers in their planning and management activities. However, methods for gathering these data can be costly and time consuming, particularly over large areas. The use of hydroacoustic technology for monitoring SAV coverage improves spatial coverage at minimum cost. Using this method spatial and temporal changes in seagrass abundance can be measured and interpreted with respect to prevailing environmental conditions. In this thirteen year study (1996-2009), hydroacoustic techniques were used to assess the spatial and temporal fluctuations in the seagrass coverage of the Caloosahatchee River Estuary in relation to freshwater inflow, annual rainfall (wet and dry years) and extreme weather events (El Nino, La Nina).

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SEED ADDITION FACILITATES ZOSTERA MARINA (EELGRASS) RECOVERY IN A COASTAL BAY SYSTEM (USA)

Eleven years of Zostera marina seed additions conducted in a coastal bay system where Z. marina had not been reported since 1933 has resulted in a rapid rate of Z. marina expansion beyond the initially seeded plots. Following initial success of adult plant test plots, we initiated repeated seed introductions using millions of seeds in large scale (>100 m2) plots, mimicking large seed recruitment events in areas where the relative isolation from the nearest seed-producing beds may have resulted in rare, low-density seed input since 1933. Over 11 years, 37.8 million seeds were added to 369 individual plots ranging in size from 0.01 to 2 hectares totalling 125.2 hectares in four coastal bays. Subsequent expansion from these initial plots has resulted in approximately 1700 hectares of bay bottom containing Z. marina through 2010. This expansion is primarily attributable to multiple generations of seedlings derived from our originally seeded plots, rather than to direct vegetative growth of Z. marina. Seven years of spatially-intensive and continuously-monitored water quality data show conditions in all four bays are adequate to support Z. marina growth. In particular, median chlorophyll levels were generally 5-6 μg/l, and median turbidity levels, while exhibiting seasonal differences, ranged from 10 to 15 NTUs. The development of these beds has already influenced key ecosystem conditions, with significantly reduced turbidity and chlorophyll and increased retention of fine sediments evident in vegetated areas. This seed based restoration effort may represent one of the most successful seagrass restoration efforts to date, and has relevance to understanding the role seeds may play in Z. marina plant dynamics throughout its range.

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NUTRITIONAL STRESS INDUCES SEX REVERSAL IN MYTELLA CHARRUANA, AN INTRODUCED MARINE MUSSEL IN THE SOUTHEASTERN UNITED STATES

Mytila charruana is a mussel species currently invading the United States southeastern coastline, originating from Central and South America. M. charruana is a euryhaline species, living in both marine and brackish waters. A previous study showed that M. charruana sex ratio in the non-native environment was female-biased. Moreover, the adults had the ability to reverse sex from female to male in response to nutritional stress. The purpose of this study is to characterize the process of sex reversal in response to food availability. According to our data, in starvation conditions M. charruana is capable of undergoing sex reversal within two weeks (from female to male). Only a subset of the population reverses sex. After one week in the starvation condition, we observed male mussels with a significantly lower number of mature sperm sacs as compared to control males. These individuals might be females that re-absorbed their eggs and began spermatogenesis, reversing sex to male. After two weeks, male mussels in the starvation condition showed a considerable increase in the number of mature sperm sacs as compared to mussels at one week starvation. During the two week period, the female gonads we observed did not appear significantly different between the control and starvation conditions. The fact that a subset of the female population did not reverse sex may be due to either genetic factors or environmental factors, or a combination of both. As a result, M. charruana may be able to conserve energy at times of depleted nutrients, and survive long enough to reproduce at optimal conditions. Sex reversal would allow M. charruana to out-compete the native species that do not have this ability.
Grove restoration and creation efforts are increasingly proposed as mechanisms to compensate for mangrove loss (which has been high in recent decades: ~30-50% global loss). However, ecosystem development and functionality following mangrove restoration and creation is poorly understood. In this study, we used a 20-year chronosequence of created mangrove sites in Tampa Bay, FL to compare created and natural wetlands and quantify the rate of soil and vegetation change following creation. Our study design included nine created wetlands of different ages (0-20 years) and nine natural reference wetlands. We quantified soil properties at two depths (0-10 cm, 10-30 cm) and compared vegetation at multiple strata. Since natural mangroves typically have high soil carbon pools (ie, deep peat) and created wetlands begin as uplands, we were especially interested in the rate of soil change following creation. Relative to natural mangroves, created wetland soils had higher bulk densities, higher sand content, lower soil organic matter (SOM), lower total carbon (TC), and lower total nitrogen (TN), especially in the deeper layer (10-30 cm). In the upper soil layer (0-10 cm), a shallow carbon-rich peat layer developed; SOM, TC, and TN in this layer increased rapidly with site age. Across the 20-year chronosequence, our sites underwent succession from salt marsh to mangrove-dominated communities. After twenty years, adult tree diameter and density in the created wetlands was still significantly smaller than in natural mangroves. Plant and soil change across the chronosequence were tightly linked; forest growth was likely driving surface layer peat development. In addition to illustrating relatively rapid soil-vegetation change after mangrove creation, our results quantify key differences between natural and created wetlands which is valuable information for natural resource managers wishing to sustain existing mangroves or restore functionality via wetland creation or restoration.

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A COMPREHENSIVE SHELLFISH HABITAT RESTORATION APPROACH FOR CHARLOTTE HARBOR NATIONAL ESTUARY PROGRAM

Charlotte Harbor National Estuary Program (CHNEP) developed a comprehensive approach for shellfish habitat restoration in its southwest Florida estuaries. CHNEP encompasses 735 square kilometers of estuaries and 12,170 square kilometers of watershed. Management actions are guided by the Comprehensive Conservation and Management Plan (CCMP) which identifies Priority Problems and Priority Actions. Shellfish habitat restoration efforts (i) implements the CCMP Priority Actions for restoring native habitats and involving the public in restoration activities. Oyster habitat and shellfish harvest area closures are environmental indicators for CHNEP. The purpose is to provide a list of priority projects that implement the restoration goals, allowing the projects to be more competitive for funding and “shovel ready” for implementation. The projects are consistent with the identified areas, locations and types of shellfish habitat restoration needs identified. The process used to develop the shellfish habitat restoration needs engaged CHNEP partners to: develop maps of historic and current shellfish habitats using aerial photography and GIS; develop maps of on-going shellfish habitat restoration projects; host a workshop to refine data and identify next steps; develop a CHNEP Shellfish Habitat Restoration Plan with assistance from local and regional experts; and seek approval of the plan from the CHNEP Technical, Citizens, Management and Policy Committees. The CHNEP Shellfish Restoration Plan includes: the value of shellfish and need for habitat restoration; shellfish basins and habitat requirements; habitat restoration locations and types of projects needed; challenges for implementing restoration; design options for restoration projects; mapping and monitoring requirements for shellfish and restoration; partnerships and collaborations for restoration; estimated costs of restoration projects; and steps towards implementing the restoration plan.

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DENITRIFICATION IN THE TIDAL POTOMAC RIVER: CONTROL BY REDOX, SALINITY AND RIVERINE NITRATE INPUTS

Denitrification in the tidal Potomac River was measured in August 2010 and May 2011 using core incubations. Duplicate cores from 24 stations were collected across the whole length of the tidal river, from the Washington DC metropolitan area to the mainstem Chesapeake Bay. The N2:Ar technique provided net N2 effluxes. In August the main mode of denitrification was coupled nitrification-denitrification because of low water column nitrate concentrations. The August denitrification efficiency averaged only 25% despite the aerobic conditions at many sites, while sediment oxygen demand averaged a modest 1.5 mmol m-2 h-1. Preliminary results from our May 2011 transect showed higher rates of sediment oxygen demand with a large part of the subestuary influenced by high freshwater flow/high nitrate concentrations. Environmental controls on Potomac denitrification included sub-pancyclostome oxygen limitation of coupled nitrification-denitrification, overlying water nitrate concentrations in the aerobic tidal freshwater sub estuary, and rates of sediment respiration.

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RELATIONSHIP BETWEEN WATER QUALITY AND TOTAL BACTERIA AND VIBRIONACEAE CONCENTRATIONS IN EASTERN OYSTERS (CRASSOSTREA VIRGINICA)

The relative contribution of nitrogen and phosphorus sources in the Delaware Inland Bays watershed comes from various sources such as agriculture, urban development, septic systems, point sources and forest are the primary reasons for eutrophic condition. In addition to nutrient dynamics, bacterial assemblages fulfill an important role in estuarine ecology. Members of the Vibrionaceae family have been involved in the uptake and remineralization of macronutrients such as carbon, nitrogen and phosphorus, however, the relationship between water quality parameters and vibrios in the estuarine environment is still in question. The primary objectives of this study were twofold: i.) evaluate the total bacteria and Vibrio concentrations in Crassostrea virginica collected at two oyster gardening sites located in Delaware Inland Bays and ii.) investigate the colonization of naturally occurring Vibrio species in C. virginica among various water quality conditions in a controlled laboratory setting. The parameters studied were salinity, total suspended solids, and nitrate levels in laboratory setting. The control oysters yielded lower Vibrio levels than the high salinity treatment, high nitrate treatment and the high total suspended solids treatment during the laboratory experiment. The levels of Vibrio species, total bacteria, alkalinity, nitrate, nitrite, total nitrogen, total phosphorus, total reactive phosphorus, temperature, salinity and dissolved oxygen were significantly different (P<0.05) between the study sites. A significant interaction between the study sites and dates was observed for levels of Vibrio species, alkalinity, nitrate, total reactive phosphorus, total suspended solids, temperature, salinity and dissolved oxygen (P<0.05). The high bacteria levels were primarily due to differences in the salinity gradient.

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MID-ATLANTIC COASTAL WETLAND ASSESSMENT: MONITORING TIDAL WETLANDS THROUGH RAPID AND INTENSIVE METHODS TO SUPPORT BETTER MANAGEMENT STRATEGIES

The Mid-Atlantic Coastal Wetlands Assessment (MACWA) was developed in the Delaware Estuary to determine the health and track the status of the extensive fringing tidal wetlands that provide critical ecosystem services such as carbon sequestration, water quality improvements, flood protection, and habitat and nutrition for wildlife. The program has been expanded to include coastal wetlands along New Jersey’s Atlantic coast. Efforts to regulate and preserve coastal wetlands in the Mid-Atlantic are currently hampered by a lack of high

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MANGROVE SOIL AND VEGETATION CHANGE AFTER TIDAL WETLAND CREATION: A 20-YEAR CHRONOSEQUENCE IN TAMPA BAY, FL

Mangrove restoration and creation efforts are increasingly proposed as mechanisms to compensate for mangrove loss (which has been high in recent decades: ~30-50% global loss). However, ecosystem development and functionality following mangrove restoration and creation is poorly understood. In this study, we used a 20-year chronosequence of created mangrove sites in Tampa Bay, FL to compare created and natural wetlands and quantify the rate of soil and vegetation change following creation. Our study design included nine created wetlands of different ages (0-20 years) and nine natural reference wetlands. We quantified soil properties at two depths (0-10 cm, 10-30 cm) and compared vegetation at multiple strata. Since natural mangroves typically have high soil carbon pools (ie, deep peat) and created wetlands begin as uplands, we were especially interested in the rate of soil change following creation. Relative to natural mangroves, created wetland soils had higher bulk densities, higher sand content, lower soil organic matter (SOM), lower total carbon (TC), and lower total nitrogen (TN), especially in the deeper layer (10-30 cm). In the upper soil layer (0-10 cm), a shallow carbon-rich peat layer developed; SOM, TC, and TN in this layer increased rapidly with site age. Across the 20-year chronosequence, our sites underwent succession from salt marsh to mangrove-dominated communities. After twenty years, adult tree diameter and density in the created wetlands was still significantly smaller than in natural mangroves. Plant and soil change across the chronosequence were tightly linked; forest growth was likely driving surface layer peat development. In addition to illustrating relatively rapid soil-vegetation change after mangrove creation, our results quantify key differences between natural and created wetlands which is valuable information for natural resource managers wishing to sustain existing mangroves or restore functionality via wetland creation or restoration.
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RIVER DIVERSIONS AS A COMPONENT OF THE STATE OF LOUISIANA’S STRATEGY TO ACHIEVE A SUSTAINABLE COASTAL ZONE

The State of Louisiana has experienced a severe loss of coastal wetlands during the past century, much of which has been due to the decoupling of the flow of the Mississippi River from coastal wetlands that resulted from the leveeing of the river in the 19th and 20th centuries for flood control and navigation purposes. The State, together with its federal partners and the academic and non-governmental community, has developed a number of plans for achieving a sustainable coastal zone. These strategies envision a toolbox of coordinated protection and restoration actions that will need to be undertaken. A critical component of that toolbox is to construct new and operating existing diversions from the river to distribute freshwater, nutrients and sediments to the coastal wetlands. The State has, together with its federal partners, built and is currently operating several diversions and siphons in southeast Louisiana intended to deliver freshwater into coastal basins. One diversion (West Bay) was built to deliver sediment from the Mississippi River to build coastal wetlands. The State and its partners are currently evaluating the physical and ecological responses of those receiving basins to diversions operations. Additional diversions for the delivery of freshwater and sediments in coastal wetlands have been identified as future components of State, federal, and non-governmental strategies. These projects are being planned to coordinate with other protection and restoration actions. For example, diversion inflows would nourish wetlands created with dredged sediment in addition to creating new land themselves. This poster will detail the State’s integrated strategy for achieving a sustainable coast, with diversions as a component. This poster will specifically detail the past diversions that have been constructed throughout southeast Louisiana, as well as the multiple diversions that have been proposed or are currently in some level of study or planning.

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SPATIAL VARIABILITY OF MARSH SEDIMENTATION PROCESSES IN DYKE MARSH PRESERVE (VA, USA)

Tidal freshwater marshes are critical components of fluvial and estuarine ecosystems, yet sediment dynamics within them have not received as much attention as their saltwater counterparts. This study examines sedimentation in Dyke Marsh Preserve, located on the Potomac River (VA, USA), focusing on understanding the controls on its spatial variability. To accomplish this, push cores were collected at 26 sites across the marsh in April 2010. The character (grain size, organic content) of sediments varied considerably across the marsh, with low marsh sites generally having finer and less organic sediment than sites located in the high marsh. Sediment deposition rates were calculated with the naturally occurring radiotracer 7Be (half-life 53.3 d), using spatially variable values for sediment bulk density (generally ranging 0.2-0.4 g/cm3) and the atmospheric 7Be inventory, which varies due to differences in the duration of inundation at each site. 7Be profiles generally showed uniform activities with depth, and maximum penetration depths were typically 1-2 cm. However, not all sites had detectable 7Be, likely due to dilution by large inputs of organic material at some sites and/or net erosion at others. Deposition rates ranged 0.3-1.4 g/cm2/yr and varied significantly with elevation and distance to the nearest channel, highlighting the roles of inundation and sediment availability. These results are then compared to the vegetation community at each site to assess potential feedbacks between sedimentation, as well as to similar results in April 2011 to determine the potential interannual variability of our observations.
ESTIMATION OF BENTHIC IMPACTS OF MARINE POLLUTANTS USING TWO TYPES OF MICROCOSMS

Benthic impacts of sewage sludge by ocean waste disposal and brine by desalination were estimated using tidal flat benthic microcosms for 3 months on benthic invertebrate colonization. Two types of benthic chambers were used; plastic basket (30*20*10cm) and clear acrylic pipe (L100*D30cm). Re-colonization of macro and meiofaunochs, and chemical characterization were observed and analyzed; three levels of sewage sludge and brine treatments and three replicates for each treatment group. Changes of macro/meiofaunochs, salinity, turbidity, ignition loss (IL), COD, and total sulfur (TS) were observed every three week period. Treated concentration levels of sewage sludge in microcosm were major effect on changes of chemical properties of sediment with time, while types of benthic chamber showed significant effects on changes of benthic community structure. This study was focused on the availability of various benthic microcosms to identify the ecological impacts of marine pollutants at ecosystem level, and small size benthic microcosms well represented real ecosystem with some limitations on manipulation. This research was funded by Ministry of Land, Transport, and Maritime Affairs, Korea.

SALINITY ZONE OF THE SAN FRANCISCO ESTUARY

INCREASED RELIANCE ON MICROBIAL LOOP PROCESSES IN THE LOW SALINITY ZONE OF THE SAN FRANCISCO ESTUARY

In the fall of 2009 the City of Satellite Beach (City), Florida, authorized an investigation designed to assess its vulnerability to rising sea level and facilitate discussion of potential adaptation strategies. The project was funded through the EPA Climate Ready Estuaries Program and administered locally by the Indian River Lagoon National Estuary Program. The project was completed a year later. It is one of the first in Florida to seriously address the potential consequences of global sea level rise now forecast to rise a meter or more by the year 2100. Results suggest the tipping point between relatively benign impacts and those that disrupt important elements of the City’s built environment is +2 ft (0.6 m) above present. Seasonal flooding to an elevation of +2 ft is forecast to begin around 2050 and thus the City has about 40 years to formulate and implement an adaptation plan. Under difficult economic times and with residents now uncertain about the relationship between climate change and human activity, municipal support for undertaking the project and ultimately the acceptance of its findings are attributed to: (1) external funding, (2) inclusion of a municipal staff member on the project team, (3) establishing a Sea Level Rise Subcommittee within the City’s existing board structure, (4) public education and outreach, and (5) stakeholder confidence in the objectivity of the investigation and its recommendations. The initial steps towards implementing an adaptive management plan were expected to take place annexed to the City’s Comprehensive Management Plan. However, no formal action has been taken by the City Council because of concerns regarding how the State’s principle planning agency, the Department of Community Affairs, might react to such amendments. Recent changes in the manner and extent to which State agencies respond to local planning decisions may alleviate those concerns.

DROUGHT AND THE DECLINE OF SOUTH CAROLINA BLUE CRABS

Blue crabs are a very important commercial species along the Atlantic coast of the U.S. One major concern for the blue crab fishery is that commercial landings have been on the decline throughout most of their range. In South Carolina, this decline is correlated with drought years and above average salinity in nursery habitats. Increased salinity could cause decreased crab landings through (1) increased disease prevalence, (2) increased juvenile mortality, (3) decreased larval settlement or (4) increased migration beyond the legal fishing limit. To test these hypotheses, we estimated fishing effort and crab abundance by pots at 27 stations along a salinity gradient in the three rivers of the ACE Basin NERR in South Carolina. Quarterly censuses were conducted for three years to examine blue crab distribution and abundance. Hemolymph samples were collected to determine the prevalence of the parasitic dinoflagellate Heterolobosporum sp. Crab abundance and disease prevalence varied by year, month, river and site. Disease prevalence was highest for years and sites with the highest salinity. Crab abundance varied more by river and site and was not significantly correlated with disease prevalence or fishing effort. More research is needed to distinguish if salinity affects crab abundance directly through decreased settlement or indirectly through prey and predator abundances.

TIDE AND WAVE-INDUCED VARIATIONS IN TURBULENT KINETIC ENERGY AT A BOUYANT JET DISCHARGE

Current velocity and hydrography measurements were used to determine the influence of tides and waves on turbulent kinetic energy (TKE) variations at a submarine groundwater jet discharge in a fringing reef lagoon in the Yucatan Peninsula, Mexico. Measurements were obtained through a three-day period early in the wet season (July). Velocity and pressure values were recorded at a rate of 8 measurements per second, and salinity and temperature values were acquired at 6 measurements per minute at the spring nozzle. Further measurements at nearby lagoon inlets had lower temporal resolution. Records showed that tidal variations modulated the discharge from the buoyant jet, with maximum outflow values of 0.3 m/s, when smoothed with a 20-minute low-pass filter. Values of TKE at the buoyant jet also showed a clear tidal modulation, with up to 0.36 m²/s² observed during low tides. Moreover, lagoon water temperatures were modulated by a diurnal cycle while the spring water temperature was modulated by the semidiurnal tides. Additionally, salinity at the spring was affected by semidiurnal tides and TKE variations. Highest salinities (~34 psu) occurred during high tides while low salinities (~29 psu) developed between high and low tides. At low tides, an increase in salinity was observed, which was in phase with...
maximum TKE values. This is evidence of vigorous mixing between spring and lagoon waters. Interestingly, the highest salinity detected at the jet during the measurement period was observed the first two tidal cycles, which also corresponded with high wave activity. The highest salinity was likely caused by wave-induced setup that drove more saline waters into the lagoon from the ocean (wave-pumping). Therefore, wave-pumping should enhance salt intrusion into the spring, and its aquifer source, through high tides. The combination of high tides and wave-pumping is expected to threaten delicate aquifer conditions and vital water resources for the local communities.

**Hazard Analysis and Critical Control Point (HACCP) Planning: Invasive Species Applications**

Planning is nothing new for biologists and managers, but applying Hazard Analysis and Critical Control Point (HACCP) planning to conservation activities work is a relatively new concept. Without appropriate planning, activities that takes biologists and their equipment to different habitats; including habitat restoration, monitoring, biological surveys or collections, could be pathways for species spread. 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. HACCP is a five step tool that manages the risk of moving invasive species during natural resource management activities. The steps involve recognition of non-target species, risk management and assessment of potential pathways, identification of critical control points (a given activity whereby the risk of a hazard – non-target or invasive species movement) can be reduced to an acceptable level, and development and evaluation of control measures to reduce the risk of hazard. By following these steps, HACCP is designed to identify high-risk activities and focus attention on those actions needed to close open pathways. Plans documenting risks of invasive species, as well as control methods used to reduce these risks, gives managers the 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 and procedures that can be shared with others to reduce risks of invasive through pathways with similar characteristics. This presentation will provide a brief description of the steps necessary to develop and implement a HACCP plan. It will also provide examples of projects where HACCP has been utilized, emphasizing the benefit of this tool in reducing the spread of invasive species in the course of conservation efforts.

**Stressed Out Oysters: Measuring Sublethal Responses Using Stable Isotopes and Protein Regulation**

Organisms inhabiting coastal waters are exposed to anthropogenic and naturally occurring hypoxic events. These events can affect growth, survival, and current there are not reliable methods to examine cumulative or sublethal stress. We transplanted hatchery-reared oysters to historically normoxic (Sand) and hypoxic (Denton) reefs in Mobile Bay, AL and monitored physical, biological and chemical parameters of the environment and the oysters. Stable isotope ratios and protein regulation were measured in oyster tissues of juvenile and adult age classes. Because oysters are relatively tolerant of low oxygen events, these data are useful to quantify the sub-lethal stress response that traditional growth and survival measurements may not. We found heavier δ18O in tissues of oysters under lower dissolved oxygen conditions (DO) at Denton reef in 2008 and at both reef sites in 2010. This increase in δ18O is consistent with reduced feeding and catabolism of tissues, common to bivalves under stressful conditions. These data indicate that stable isotope analysis can detect cumulative stress responses to low DO. Protein regulation of p38 MAPK was also consistent with stress; the oysters hypoxic sites upregulated this protein. We also consider whether the lower DO concentrations and putative higher stress among oysters at Sand reef in 2010 were a secondary effect from the Deepwater Horizon oil spill.

**Where the Rubber Hits the Road: Local Land Use Decisions and Protecting Water Quality in the St. Mary’s River (Maryland) Watershed**

Estuarine and river water quality is strongly tied to land use practices. While broad and general policies promulgated by federal and state governments help deter water quality degradation, countless local land use decisions made every day by local planning boards and commissions have the potential to seriously erode well-intentioned policy. Some environmentalists call these quiet and often ignored decisions “death by a thousand small cuts.” We have been collecting water quality data in the St. Mary’s River watershed since 1999 with the objective of influencing local environmental policy. Yet, like many scientists, we have difficulty translating our science and conclusions into language and actions that will inform policy. Furthermore, we have found it difficult to muster the energy necessary to engage in government decision making. Therefore, we have found that an intermediate group, active in local government negotiations, is essential for translating our science into action. This task has been assumed by our local citizen-based watershed association, the St. Mary’s River Watershed Association. The St. Mary’s River is a good model for other small estuarine watersheds where development pressures on coastal environments such as the Chesapeake Bay are intense. St. Mary’s County is currently the fastest growing county in Maryland, and because our watershed is contained entirely within the county, its fate is in the hands of local government. Our local politicians face the choice either balancing budgets with increased tax revenues generated from development dollars or losing revenues by curtailing development and protecting environmental quality. These are very real challenges that face every estuary and watershed despite broader policy efforts to protect water quality. Therefore, federal and state mandates may have limited impacts when the rubber hits county roads.

**EcoLOGY OF HARMFUL CYANOBACTERIA (LYNGBYA spp.) IN THE INDIAN RIVER LAGOON**

Benthic cyanobacteria (blue-green algae) are becoming increasingly abundant in many coastal habitats including the Indian River Lagoon (IRL). They produce nitrogenous natural products that can deter feeding by generalist herbivores and may play a role in competitive interactions. Many species of *Lyngbya, Oscillatoria*, *Phormidium* and *Symploca* occur regularly throughout Florida, especially during the summer months, and these have yielded a diversity of natural products. We have sampled *Lyngbya* spp. in the IRL for the past six years, and in the summers of 2008 and 2011 we quantified the abundance of these cyanobacteria in the IRL near Fort Pierce, FL, over the course of the summer. The abundance of *Lyngbya* spp. was highly variable at different sites throughout the spring and summer, ranging from 0-100% cover. Several different species were common and

**STRESSED OYSTERS: MEASURING SUBLETHAL RESPONSES USING STABLE ISOTOPES AND PROTEIN REGULATION**

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**WHERE THE RUBBER HITS THE ROAD: LOCAL LAND USE DECISIONS AND PROTECTING WATER QUALITY IN THE ST. MARY’S RIVER (MARYLAND) WATERSHED**

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**ECOLOGY OF HARMFUL CYANOBACTERIA (LYNGBYA spp.) IN THE INDIAN RIVER LAGOON**

Benthic cyanobacteria (blue-green algae) are becoming increasingly abundant in many coastal habitats including the Indian River Lagoon (IRL). They produce nitrogenous natural products that can deter feeding by generalist herbivores and may play a role in competitive interactions. Many species of *Lyngbya, Oscillatoria*, *Phormidium* and *Symploca* occur regularly throughout Florida, especially during the summer months, and these have yielded a diversity of natural products. We have sampled *Lyngbya* spp. in the IRL for the past six years, and in the summers of 2008 and 2011 we quantified the abundance of these cyanobacteria in the IRL near Fort Pierce, FL, over the course of the summer. The abundance of *Lyngbya* spp. was highly variable at different sites throughout the spring and summer, ranging from 0-100% cover. Several different species were common and
occasionally formed blooms on seagrass and sediments, and they produced a variety of natural products.

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STRATIFICATION ON THE SKAGIT BAY TIDAL FLATS

The processes controlling stratification on the Skagit Bay tidal flats in Puget Sound, WA are studied with Finite Volume Coastal Ocean Model (FVCOM) simulations and with measurements of water velocities, densities, and depths. Skagit Bay is a shallow, periodically stratified estuarine transition zone in which salinity varies from 1 to 28 PSU. Circulation is influenced by the Skagit River discharge (about 250 to 850 m3/s during the study period) and tidal flows. The spring tidal range is about 4 m, maximum tidal velocities typically are about 0.4 m/s, the bed slope is about 0.001, and maximum water depths on the flats (which are exposed to air at low tide) range from 1 (upper flat) to 4 m (lower flat). The model incorporates high-resolution bathymetry and is forced with boundary conditions that include observed river discharge, surface winds from a regional wind model, and tides based on harmonic analysis and observed low-frequency variability. The model simulations are compared with field observations (obtained during summer 2009) that show that tidal straining, advection, and mixing are the dominant processes controlling the time-dependent stratification at one mid-flat location. The model is used to examine how stratification varies with cross-shore position and distance from the river mouth, and with river discharge and tidal forcing. The relative importance of straining, advection, and mixing is assessed and related to local depth and density gradients. Model results for the northern and southern portions of Skagit Bay, as well as the upper and lower tidal flats are compared and contrasted. Conclusions are interpreted with the goals of predicting conditions in similar regions and developing methods to test such predictions. Funded by ONR, NSF, and NSSEFF

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CAN STABLE ISOTOPES FROM OTOLITHS REVEAL LONG TERM DIET CHANGES IN NORTH ATLANTIC COD (GADUS MORHUA)?

Climate change and exploitation can alter the structure of coastal marine ecosystems and may include food web changes that affect the productivity of commercially important fish species. Stable isotope (δ15N & δ13C) analyses of various tissues have successfully been used to study diet changes in many different aquatic organisms. Due to lack of properly preserved tissue samples few studies have used stable isotopes to estimate long-term diet changes in fish populations. Here, we show that the δ15N & δ13C signature of fish diets can be estimated from the soluble organic matrix in otoliths, which, due to the large historical collections of otoliths, enable us to document current and historical changes in ecosystem structure and the trophic position of individual fish. To analyze δ15N & δ13C in the organic otolith matrix we developed an extraction method based on less than 70 mg otolith material. The method was validated in the lab for juvenile cod (Gadus morhua) fed a range of diets (blue mussel, sandeel & whiting). The average δ15N & δ13C in the otolith matrix was remarkably close to the δ15N & δ13C in the corresponding diets with an isotopic fractionation between -0.1 to 0.5‰. We then developed long-term δ15N & δ13C chronologies for cod stocks off Greenland (1927-2006) and the Faroe Islands (1950-2010). In both areas we found significantly different time periods with alternating high and low δ15N (8.8 - 12.2‰) & δ13C (-15.5 - -19.5‰) values. We also found a significant correlation between δ15N & δ13C over time, indicating that δ15N & δ13C values were affected by the same overall processes. These studies show that it is possible to exploit the large inventories of otoliths worldwide to track changes in the trophic structure of marine ecosystems with very high spatial and temporal resolution.

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THE MISSING LINK: DO POSTLARVAL WHITE SHRIMP LITOPENAEUS SETIFERUS USE PRESSURE AND SALINITY AS CUES FOR ESTUARINE IMMIGRATION?

The mechanisms underlying postlarval white shrimp Litopenaeus setiferus recruitment are poorly understood, but may be associated with behavioral responses to chemical and physical cues because larvae are dependent on tidal transport for inshore movement. Understanding behavioral responses of shrimp to environmental cues is an essential first step in developing a model to describe postlarval recruitment of this species. The purpose of this study is to determine if shrimp respond to changes in the rate of increase of salinity and pressure which occur during the onset of flood tide. Postlarval swimming responses to salinity will be investigated by placing groups of 25 postlarvea into a Lucite observational chamber and exposing specimens to a constant rate of increasing salinity by pumping high salinity water from a reservoir into the observation chamber. Swimming responses will be quantified as the % change in the number of shrimp occupying the top 1/3 of the experimental chambers. Swimming responses to rate changes in pressure will be conducted using a similar type apparatus with a water filled tube attached to a sealed observation chamber. The tube will be raised at a constant rate to produce a constant pressure increase in the chamber. Swimming responses will be determined in an identical manner to salinity experiments. All swimming responses will be compared to swimming activity exhibited under constant conditions (control). Experiments will be conducted in the laboratory under far-red light and recorded with digital video cameras. If salinity is a primary cue for ingress, proper management of freshwater inflow into estuaries may be essential for sustaining viable shrimp fisheries. Regardless of the outcome, findings from this study will be useful for identifying the primary environmental cues that shrimp postlarvae can use for ingress into estuaries from coastal regions.

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COMPARATIVE ANALYSIS OF CLIMATIC FORCING ON PHYTOPLANKTON COMMUNITY DYNAMICS IN TWO NEIGHBORING, MID-ATLANTIC ESTUARIES

Successful management of estuarine eutrophication depends in part on understanding the complex relationship between phytoplankton biomass (chlorophyll a) and riverine discharge, the dominant external nutrient source. Complications arise from climate variations and additional factors that may covary with discharge, including advective losses, grazing, temperature, salinity, light, and nutrient concentrations. The study’s goal was to isolate the discharge-chlorophyll a (chl-a) response signal in 3-year time series from two neighboring, shallow (≤ 5 m), microtidal estuaries (New and Neuse River estuaries, NC) influenced by the same climatic conditions and events. Within both estuaries, chl-a was maximal at moderate discharge rates and a Gaussian optimum function provided a reasonable and statistically significant approximation of this relationship. The best fit functions showed that the discharge associated with highest chl-a increased seaward along the longitudinal axis. Observed unimodal relationships between discharge and chl-a reflect a balance between advective losses and nutrient stimulation of biomass by riverine loading, particularly within mid-estuary regions. At the highest flows, chl-a was greatly reduced in the upper regions of the Neuse and throughout the New River estuary. Calculated flushing times (fresh water replacement) revealed a threshold of approximately one week, below which biomass accumulation was restricted by advective losses. Residual analysis of the fitted data revealed positive relationships between chl-a and temperature. Temperature effects were strongest near the mouth of both estuaries where flow effects were weakest. This may have resulted from temperature-enhanced sediment nutrient regeneration where riverine loads were exhausted. These results highlight the spatial differences in discharge impacts on phytoplankton biomass and will help predict estuarine phytoplankton and ecosystem response to future climate and anthropogenic changes.

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Societies, Estuaries & Coasts: Adapting to Change

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IMPORTANCE OF WATERSHED LAND USE IN PREDICTING BENTHIC INVERTEBRATE CONDITION IN THE VIRGINIAN BIOGEOGRAPHIC PROVINCE, USA

Estuaries are dynamic transition zones linking freshwater and oceanic habitats. These productive ecosystems are threatened by a variety of stressors including human modification of coastal watersheds. In this study we examined potential linkages between estuarine condition and the watershed by developing regression models between landscape condition indicators and benthic invertebrate communities. We examined variables at the watershed and riparian scale to determine if the spatial arrangement was important in predicting benthic invertebrate condition. Since they were highly correlated, either riparian or watershed variables were adequate for assessing estuarine invertebrate condition. Modeling estuarine condition indicated that inherent landscape structure (estuarine area, watershed/estuary ratio) is important to predicting benthic invertebrate condition. Estuarine area was positively related to invertebrate condition while the watershed/estuary ratio was negatively related. As shown in other studies, more natural land cover features (wetland, pasture/hay) help improve estuarine condition while anthropogenic impacts (development, sewage treatment plants) can have adverse impacts. Our results emphasize the importance of considering the value of natural land as well as the minimization of the effects of development through best management practices.

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GEOGRAPHIC VARIATION IN SALT MARSH FOOD WEBS

Salt marshes along the Atlantic and Gulf Coasts of the United States are superficially homogenous, with a similar physical structure and similar plant and animal communities dominated by a few widespread taxa. Geographic comparisons of these systems, however, have revealed striking ecological differences in function. Geographic gradients in climate, soils and tidal range lead to geographic variation in plant productivity, quality of plants as food for herbivores, and plant phenology. These differences in turn lead to geographic differences in herbivore abundance and damage, plant defenses, and controls on food web structure. In particular our studies in North American salt marshes have 1) suggested that latitudinal variation in plant quality may help explain Bergmann’s rule, 2) shown that geographic variation in phenology and food web composition were more important than geographic variation in plant quality in mediating geographical variation in herbivore population density, and 3) revealed strong linkages between latitude and tidal range in structuring the trophic composition of food webs. Understanding geographic variation in salt marsh function is essential for building towards a general understanding of how salt marshes work, and is the only way to examine the importance of variables such as tidal range that vary on geographic scales.

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THE HYDROGRAPHY OF A HIGHLY STRATIFIED ESTUARY LOCATED IN A TROPICAL AND MICROTIDAL REGION: THE JAMAPA RIVER ESTUARY, VERACRUZ, MEXICO

Three shipboard surveys were conducted in order to determine the seasonal and intra-tidal variation of the hydrographic characteristics of a microtidal, tropical estuary located in the western part of the Gulf of Mexico, the Jamapa River Estuary. This work represents the first effort to produce the hydrographic characterization of this coastal system that is about 8 km long, 80m wide and, in average, 3m deep. The Jamapa River estuary is a sanctuary of the blue-crab and it discharges into a natural protected area named Veracruz Coral Reef System National Park. The estuary has been negatively impacted due to the diverse human activities (mostly industrial) that take place along the drainage basin and at the estuary itself. All the surveys took place during spring tide conditions and during the three well defined seasons in this region, named: dry, rainy and “nortes” (northerly wind condition), respectively. In each survey an axial grid of 13 stations were sampled repeatedly during a diurnal tidal cycle (25h). The results show that: (1) the Jamapa River estuary is a highly stratified system, where tide plays an important role on the salt wedge displacement. (2) The position of salt wedge is strongly modulated by the river discharge. During high river discharge the salt wedge is flushed out of the estuary, restricting the salt wedge intrusion to the landward side of the mouth. During low river discharge, the salt wedge is located at 8 km from the mouth. (3) The mixing action of the northerly wind affects only the water column close to the estuary entrance, while up-estuary the water column remains strongly stratified throughout the tidal cycle.

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NUTRIENT DYNAMICS OF BENTHIC FLORA IN FLORIDA BAY: A LONG-TERM APPROACH

Using an enrichment experiment as a precursor and a hypothesis for future Benthic Flora (BF) community structure, coupled together with a long term monitoring program can be an effective way of interpreting changes in long-term trends and predicting future impacts of increased nutrients on coastal systems. Shifts between slower growing species dominance to faster growing species dominance is expected when there is an increase in nutrients in the system (i.e. eutrophication). In this study we focused on the community structure of calcareous green algae (CGA) and seagrasses and their response to nutrient availability and salinity variability as a community driver. We investigated one main question for our enrichment experiment, do enrichments in N and P affect community composition under two contrasting salinity regimes? We expect that with an increase of nutrients in the systems that the seagrasses T. testudinum, S. filiforme, and H. wrightii will be displaced by the faster growing CGA's. Another major focus of this research is to observe if long-term trends during our four years of monitoring are beginning to mimic our enrichment experiment results. Enrichment and long-term monitoring nutrient content data revealed our BF to be P-limited, while CGA long-term nutrient content varied through time. Salinity generally decreases in benthic flora abundance and diversity, however our enrichment led to an increase in seagrasses and a decrease in CGA's in both our study sites. Based on nutrient content and abundance of both seagrasses and CGA's, interesting competitive interactions were revealed. We may potentially be observing a phase-shift, where abundance of macroalgae is decreasing while seagrasses are increasing, in which case the conceptual model that macroalgae will displace seagrasses when eutrophication occurs needs to be modified.

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SEA TEAM – CITIZEN SCIENTISTS IN SARASOTA

In 2006, prior to the acquisition of aerial photography by the Southwest Florida Water Management District for the biannual seagrass mapping effort, Sarasota County took on an effort to conduct concurrent ground-truthing of seagrass presence/absence within its bays. The result was an average 76% accuracy between points collected during the survey and mapped seagrass polygons, over all bay segments. Through that effort, we identified a need and methodology to gather data to help us understand our seagrass habitats that would become a biannual (summer/winter) sampling event that started in 2007. That year, the Sarasota County began training volunteers to locate and identify seagrass species and those factors that influence its growth: epiphyte coverage, drift algal coverage, the presence of grazers and sediment characteristics. Their data along with that collected by staff are submitted for use in aiding photo interpreters in identifying seagrass beds and has created the first map for Sarasota County depicting the distribution of seagrass species throughout its waters, identifying areas of drift algae and epiphyte cover. This group, the Sarasota Environmental Aquatics Team, or SEA Team, has expanded beyond seagrass to working with bay scallops; participating in scallop searches, assisting with spat monitoring and raising scallops on their docks to monitor growth rates and providing a protective environment for them to spawn and possibly restocking the estuary. Bay scallop monitoring has gained the support the Fish and Wildlife Research Institute of the Florida Fish and Wildlife Conservation Commission. The SEA Team’s Citizen Scientists were recently recognized (2009) by the Gulf of Mexico Program with a Gulf Guardian Award.

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A COMPARISON OF NEKTAN ASSEMBLAGES FROM NATURAL AND RESTORED BARRIER ISLAND MARSHES IN TERREBONNE/TIMBALIER AND BATARATIA BASINS IN LOUISIANA

We compared nekton assemblages from natural and restored barrier island marsh habitats in two major estuaries in southeast Louisiana. We were particularly interested in the status of several fish species of conservation concern (SOCC). We sampled for one year at two restoration locations in the Terrebonne/Timbalier estuary and the next year at two different restoration locations in the Barataria Bay estuary. Nekton samples were collected with benthic minnow traps and 3-m seine. Both restored and adjacent natural marsh ponds and creeks were sampled bimonthly at each of the restoration locations. Environmental variables were recorded for each sample collected. Fish species composition and abundance data were analyzed using CLUSTER, ANOSIM and SIMPER procedures with Primer v6 software.

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Twenty-eight species were collected in traps with half (14 spp) common to both natural and restored marshes. Seven species were unique to each category resulting in 21 species in each (natural and restored trap samples). Sixty-four species were captured in seines in natural and restored sites, but 8 species found in each category did not occur in the other resulting in 56 species in each category. We collected 4 of (11 listed) marine fish SOCC: Adinia xenica, Fundulus jenkinsi, Fundulus vulpecuues, and Synagynthus louisianae. Cluster dendrograms illustrated that differences in species assemblages generally greater between than they were between natural and restored marshes within each island. The greatest differences were between estuaries which could be due to geographic distribution or may have resulted from annual variation, since the Timbalier/Terrebonne locations were sampled during year one (2007-8) and the Barataria locations were sampled during year two (2008-9), and hurricanes Gustav and Ike impacted this area between the two sampling periods. 

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MEASURING THE EFFECTS OF TYPHA DOMINGENESIS ENCROACHMENT ON PANAPICUM HEMONTOMIN MARSH, IN SOUTHEASTERN COASTAL LOUISIANA

Through this proposed study I would like to learn how nutrient levels are a factor in the expansion of Typha domingensis into Panicum hemontomin marshes. Also I believe that salinity plays a more roles in species expansion and I would like to see how significant the salinity factor is. Lastly I would like to learn how the changing of dominate plant species is affecting fresh marsh sustainability. Increasing freshwater flow through an area is often used as an avenue for restoring freshwater wetlands in Louisiana. Doing this, not only increases the volume of fresh water introduced but also increases nutrient levels. Some marsh plants can thrive on the raised levels of nutrients and outcompete the previous dominate species in the marsh. This appears to be what is happening in the Panicum hemontomin marsh that is now being encroached upon by Typha domingensis. Typha domingensis is known to have spread into native Cladium jamaicense freshwater ecosystems throughout the Florida Everglades. Furthermore, it is known that this spread is caused by higher levels of phosphorous being introduced, through waste water drainage from cities and farmland run off, into these ecosystems. Unlike the Everglades the salinity variation in Louisiana marshes is seen as a contributing factor of plant species distribution.

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DEVELOPMENT OF A SHORE PROFILE ALGORITHM: A CASE STUDY OF WEEKS BAY, ALABAMA

Numerical models are continually evolving to enhance the overall accuracy of results. However, the typical shoreline in a model is lacking significantly in resolution. This work defines the shore as a nonlinear profile which will provide more realistic models. Limited field data is available in these regions due to the difficulty of measurement. The collection of data was coupled with numerical analysis to develop an appropriate shore profile algorithm. Weeks Bay, an estuary in southern Alabama, was used as a field testing site. The shorelines examined were composed primarily of fine sediments inhabited by marsh grass. Field data collection included shore profile elevations and grain size distributions as well as other water quality parameters. Shorelines in the region have very little weight-bearing capacity, driving the need for a new method of measuring shore profiles. Because the field sites were accessible only by water, traditional benchmark land leveling could not be used. New methods, including the use of technology such as GPS and ADCPs, were developed and tested. A hybrid form of land leveling was deemed the most accurate approach. The profile data were then tested against a variety of shore profile equations. The most applicable, an equation by S. C. Lee, was modified in order to calculate the entire shore profile length. The distance from the land-water interface to the depth at which sedimentation is negligible can now be modeled with a single equation.

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A REVIEW OF GLACIER AND ICE SHEET CONTRIBUTIONS TO SEA LEVEL RISE IN THE 21ST CENTURY

A significant fraction of present-day sea level rise occurs by the transfer of new water mass from land to the ocean, through a combination of melting and runoff of ice stored in glaciers and ice sheets and direct discharge of icebergs into the ocean. This transfer is expected to continue into the future, probably at accelerating rates. The determination of those future rates, however, is highly uncertain. Present-day glacier and ice sheet loss rates are determined by a variety of remote-sensing and ground-based methods that contain significant uncertainties. Future glacier and ice sheet losses cannot yet be reliably projected by deterministic numerical models, although progress is being made in this direction. Extrapolations of present-day loss rates are being explored as an alternative to model-based projections. The results, interpreted with care, provide limited estimates of likely sea level rise from glaciers and ice sheets as well as insights into the nature of the controlling processes; however, the time scales over which extrapolation of present-day processes is valid is yet another major uncertainty. I review the current knowledge of present-day rates of glacier and ice sheet loss rates, the limitations of current numerical models of glaciers and ice sheets, and discuss the use and limitations of extrapolation as a tool for prediction of sea level, with special emphasis on the evaluation of uncertainty.

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ANALYZING HISTORICAL CHANGES OF SEAGRASS LANDSCAPE AT HORN ISLAND, MISSISSIPPI

Changes in seagrass coverage from 1940 to 2008 at Horn Island, Mississippi are studied. The dataset with spatial resolution of about one meter allows analysis at both patch level and landscape level. Preliminary work shows that total seagrass area on the island increased from 50.7 hectares in 2003 to 82 hectares in 2006 (61.4% up), while number of patches decreased by 25% between the two years. Mean patch area and mean patch perimeter in 2006 were 2.15 and 1.28 times, respectively, higher than those in 2003. Mean distance between neighboring patches in 2006 was 14.2 meters as compared to 12.5 meters in 2003. Further analyses are made for all available seagrass layers at two temporal scales – different years in 2000’s (short term) and decadal time-course between 1940 and 2008 (longer term). Trends are considered at various parts of Horn Island (small spatial scale) and across the whole island (bigger spatial scale). How much seagrass extent and total area changed, and how seagrass patches moved or had interactions with neighboring patches are questions of interest. Different landscape metrics are considered, including (1) area metrics (also including net change per site per decade), (2) patch density, patch size and variability metrics, (3) edge metrics (plus perimeter to area ratio), (4) shape metrics, and (5) nearest neighbor metrics. Statistical tests are performed to before drawing any conclusions. This historical analysis is the first attempt to study configuration and composition of seagrass landscape in Horn Island, and to understand the process of patch movement and fragmentation.

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ENTEROCOCCI UBQUITOUS WITHIN SOUTHERN FLORIDA BEACH SEDIMENTS

Enterococci are used to assess the risk of negative human health impacts from recreational waters. Studies have shown sustained populations of enterococci within tropical and subtropical beach sediments but comprehensive survey of multiple South Florida beaches and the potential relation to beach management decisions are very limited. We sampled eight South Florida beaches in Miami-Dade and Broward counties and found that enterococci were ubiquitous within South Florida beach sands although their levels varied greatly both among the beaches and between the supratidal, intertidal and subtidal zones. The supratidal sands consistently had the highest levels of enterococci. Levels of enterococci within the supratidal and intertidal sand were found to correlate with the percentage of samples that exceeded regulatory levels (104 CFUs/100 mL). Results indicate a connection between levels of enterococci in beach water and beach sands which may suggest that the sands are the regionally the main source of enterococci to coastal waters. The most important implication from this study was that the quality of the beach waters and the quality of the beach sands are intimately intertwined. Beaches with low levels of enterococci in the sand have lower levels in the water and thus will have fewer closures than beaches with higher levels of enterococci in the beach sands.

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INTERACTIVE FACTORS AFFECTING BLACK MANGROVE AVICENNIA GERMINANS RANGE LIMIT EXPANSION IN NORTH CENTRAL GULF OF MEXICO

Coastal wetland plant communities are strongly influenced by climate. The severity of freeze events in the North Central Gulf of Mexico determines the northern range limit of black mangrove (Avicennia germinans) where it grows in association with smooth cordgrass (Spartinia alterniflora). We hypothesized that the smooth cordgrass canopy may be acting as a facilitator of black mangrove propagation and seedling survival during stressful cold temperature events. We used the Stress Gradient Hypothesis as a framework to predict positive and negative interactions between black mangrove and smooth cordgrass at four coastal salt marsh sites in the North Central Gulf of Mexico, north and south of the current black mangrove range limit. We transplanted black mangrove seedlings and propagules to plots at sites, and then removed the smooth cordgrass canopy of half of the plots. We evaluated survival, establishment, and growth of black mangrove transplants, as well as measured temperature, light level, hydrologic regime, and soil physio-chemical characteristics. Results suggest that the smooth cordgrass canopy may be facilitating
seeding survival during the winter by alleviating microclimate temperature stress. However, longer and colder freeze events that occur at more northern sites have a lethal effect on black mangrove regardless of marsh canopy and will continue to limit range expansion. Future climate change scenarios predict a warmer climate for the North Central Gulf of Mexico, and this study elucidates the potential role of existing herbaceous salt marsh canopy as a facilitator of black mangrove range expansion due to a changing climate.

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QUANTIFYING AND EVALUATING HABITAT-SPECIFIC NITROGEN REMOVAL IN ESTUARIES

Estuaries have long been regarded as filters in the freshwater marine continuum. Nitrogen removal by estuarine sediments is an important example of this filtration capacity. Oyster reefs, submerged aquatic vegetation (SAV) and salt marshes now cover small fractions of the areas they once did, resulting in an overall loss of materials processing capacity in estuaries. Because estuaries are heterogeneous and include many habitat types with distinct properties that affect nutrient cycling, habitat-specific data on these processes are critical. We used membrane inlet mass spectrometry to measure habitat-specific denitrification (DNF). The ecosystem service of N removal was quantified using simple valuation techniques for N removal provided by each habitat. We found significantly higher rates of DNF in structured habitats (SAV, salt marshes and oyster reefs) than in intertidal and subtidal flats. Higher DNF rates occurred in the warmer seasons, and patterns of DNF suggested links to habitat-specific primary production and filtration. Values of the ecosystem service of nitrogen removal were determined using rates from a regional nutrient-offset market to estimate the cost to replace N removal through management efforts. Values ranged from ~$3,000 (U.S.) per acre per year in SAV to ~$400 per acre per year in the subtidal flat. We were also interested in the proportion of the total value of ecosystems services attributable to N removal. Because oyster reefs have been the focus of significant effort to restore their provision of ecosystem services, we compared the value of all ecosystem services to the value of N removal. Oyster reefs provide ~$8,000 per acre per year in ecosystem services with N removal accounting for nearly 50% of the value. Natural and human-induced loss of structured habitats reduces the capacity to remove N, and consequently decreases the value of this important ecosystem service provided by estuaries.

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GEOMORPHOLOGIC RESPONSE OF TIDAL MARSHES TO ACCELERATED SEA-LEVEL RISE, SOUTHWEST FLORIDA

Fluctuations in sea level have driven changes in vegetation along Southwest Florida’s coastline throughout the Holocene. Predicted rates of current regional sea-level rise (SLR) vastly exceed rates experienced over the last 5,000 years. Tidal pond formation corresponds with the degradation of wetland types as a reaction to SLR, but the specific mechanism is not yet fully understood. Data on whether certain precursor habitats are preferentially degraded, and whether such degradation follows a predictable sequence, are lacking. Thus, the study’s key objectives were to 1) identify a mechanism of floral succession within tidal marshes relative to accelerated SLR via field analyses, and 2) quantify the evolution in the distribution and aerial coverage of tidal ponds using GIS methodologies. Thirty-five cores were extracted from marsh, mangrove, and tidal pond environments along 5 transects perpendicular to the tidal gradient in the Ten Thousand Islands of Collier County, Florida. Stratigraphic analyses indicate a transition from an upland environment to an intermittently flooded, short hydropodet wetland, and finally to longer hydropodet marshes or ponds. The physiological responses and community ecology of dominant flora within each ecosystem, and the role these play in the noted trends, is currently being explored. ArcGIS 9.3 software was utilized to quantify surface area and distribution of tidal ponds within 12 randomly selected marshes via analysis of aerial imagery from 1940 through 2009. Mean tidal pond area was statistically compared among the time frames. Results indicate an overall increase in the aerial extent of tidal ponds across the landscape over the past 60 years. The current geomorphology of northwestern Everglades National Park and new stratigraphic evidence from middle Holocene subsurface deposits under what is now inner shelf Guiflman Bay suggest this phenomenon of pond amalgamation has occurred iteratively in Southwest Florida’s history.

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PLANKTON DYNAMICS AND SEASONAL HYPOXIA: TRACING CAUSE AND EFFECT IN COMPLEX INTERACTING SYSTEMS

As worldwide incidences of eutrophication induced hypoxia rise, so does the attention paid to the causes and effects. However, in complex and varying systems it is often difficult to discern the mechanisms directly responsible for observed patterns. In plankton communities, this conundrum is due in large part to the disparate temporal and spatial scales over which environmental conditions vary and behaviors of individuals are exhibited. Further, plankton are often sampled as populations due to their small sizes, which makes inferences about individuals difficult. We explored the potential mechanisms driving plankton trophic dynamics in hypoxic systems using a variety of approaches, ranging from multivariate statistics to individual based models. Our results unsurprisingly suggest that species and region specific responses to hypoxia drive the observed and hypothesized patterns in food-web dynamics. However, the cumulative impacts of non-linear interactions on plankton behavior and physiological condition can lead to surprising population dynamics, which may impact trophic transfer and nutrient cycling in these systems.

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SHOREZONE CHARACTERIZATION FOR CLIMATE CHANGE ADAPTATION IN THE BAY OF FUNDY

Human settlement in environments as dynamic as the coastal zone will inevitably lead to conflict between the natural variability of the coastal environment and the economic, social and cultural activities taking place within it. In order to mitigate potential negative impacts (e.g. loss of life and infrastructure), managers and planners need to better understand coastal processes and dynamics. This requires up to date shore zone characterization including built structures and a solid understanding of the boundaries of coastal processes and historical rates of coastal change. A dynamic segmentation model was developed within ArcGIS to delineate and characterize the backshore, foreshore and nearshore zones within the Southern Bight of the Minas Basin, Bay of Fundy, Canada. This was populated with data collected during shoreline surveys using a YUMA tablet and any available aerial imagery for the region. Segments were catalogued using a customized decision key to characterize the shoreline. Areas of the coast were assessed for shoreline stability and presence or absence of a cliff (consolidated and unconsolidated). Due to the extensive foreshore areas of saltmarsh that occurred seaward of the MHW line traditionally used to define the shoreline, the edge of marsh was used to delineate shoreline change over time. These data were merged with a LIDAR elevation survey and surficial geology to provide a comprehensive overview of coastal characteristics to serve as the foundation for coastal vulnerability assessments.

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PHYTOPLANKTON PHOTOPIGMENT COMPOSITION AS AN INDICATOR OF COMMUNITY STRUCTURE, FUNCTION, AND ECOSYSTEM HEALTH

Functional group diversity (FGD) provides a more useful measure of ecosystem processes than simple species diversity indices. Assuming that an increase in functional diversity promotes ecosystem stability, homeostasis, and resilience to perturbations, then changes in FGD over time may indicate ecosystem health. Furthermore, measures of phytoplankton FGD measures over time may be a useful metric for comparing the ecosystem states for different estuaries. FGD indices were calculated using biomarker photopigment concentrations and ChemTax-derived phytoplankton group abundances for a variety of estuarine and coastal ecosystems to establish to establish numerical criteria for cross-system comparisons. Temporal changes in group diversity in the Neuse River Estuary (NC) and Galveston Bay (TX) were calculated to illustrate the application of this approach for routine monitoring of ecosystem health. The FGD approach offers a potentially useful tool for assessing both short- and long-term changes in phytoplankton biomass and community structure. Furthermore, this metric can be easily related to ecologically relevant properties such as food web structure, trophodynamics, and propensity for harmful algal blooms.
it is important to increase people’s awareness of the benefits ES provide to humans. For the newly published online database preliminary information for different study sites to be information for researchers, educators, and natural resource managers. The first can find in for future ES valuation studies. GecoServ serves as a uniquely centralized source of studies for some ecosystems and associated services, and provides background information in that it fills a void left by non-ES specific environmental databases, highlights the lack of ecosystem services (ES) valuation studies applicable to the Gulf of Mexico. Its main goals Yoskowitz, D. W., Texas A&M University - Corpus Christi, Corpus Christi, TX, USA, carlota.santos@tamucc.edu; Yoskowitz, D. W., Texas A&M University - Corpus Christi, Corpus Christi, TX, USA, david.yoskowitz@tamucc.edu GECOSERV: A WINDOW TO THE VALUE OF OUR NATURAL ENVIRONMENT

The Gulf of Mexico Ecosystem Services Valuation Database (GecoServ) is an inventory of ecosystem services (ES) valuation studies applicable to the Gulf of Mexico. Its main goals are to allow for the distribution and sharing of information about said studies and to identify current gaps in the ES valuation literature. The utility of GecoServ (www.GecoServ.org) lies in that it fills a void left by non-ES specific environmental databases, highlights the lack of studies for some ecosystems, and provides background information for future ES valuation studies. GecoServ serves as a uniquely centralized source of information for researchers, educators, and natural resource managers. The first can find in the newly published online database preliminary information for different study sites to be used in value transfer methods. Educators can learn about the economic value of ES and how it is important to increase people’s awareness of the benefits ES provide to humans. For managers, GecoServ is a tool that provides ES values to inform their decision-making process, since the inability to account for ES values can lead to a non-sustainable decision. Plunket, J. S., North Inlet-Winyah Bay National Estuarine Research Reserve, Georgetown, SC, USA, jen@belle.baruch.sc.edu; Smith, E. M., North Inlet-Winyah Bay National Estuarine Research Reserve, Georgetown, SC, USA, erk@belle.baruch.sc.edu; Willman, A., North Inlet-Winyah Bay National Estuarine Research Reserve, Georgetown, SC, USA, willman@belle.baruch.sc.edu STORM WATER DETENTION PONDS IN THE LANDSCAPE OF COASTAL SOUTH CAROLINA

Detention ponds are the most frequently used storm water management practice in coastal South Carolina. Designed to receive and retain a substantial portion of the hydrologic flow from storm events before it is discharged into coastal water-bodies, these ponds are often associated with urban development where they are also considered recreational and aesthetic amenities. Little is known about how the alteration of coastal hydrology, through the extensive construction of ponds, affects the ecological condition of adjacent coastal waters. In this study, 14,044 ponds in a coastal watershed study area were manually delineated over 2006 aerial infrared digital orthophoto quadrangles (DOQs) with 1 m ground resolution using ArcGIS software. The ponds range in size from 0.7 m² to 1.3 km², and cover a total surface area of 85 km². Relationships between the distribution of ponds and land cover within a pond buffer area of three times the radius of each pond were examined using various landscape data including NOAA Coastal Change Analysis Program (C-CAP) Regional Land Cover data and the National Land Cover Database (NLCD 2006). Although ponds tend to be associated with urban development, 34% of the land cover within the pond buffer area was in forest, 25% in wetland, and 24% in developed. However, from 2001 to 2006, 27% of the landscape change within the pond buffer area was from undeveloped to developed, compared to 5% for the entire coastal study area, and in 2006, 18% of the pond buffer area had greater than 10% imperviousness. Although many of these ponds are piped and drainage patterns can be difficult to determine, connections between ponds and waterways and wetlands could alter the biogeochemical linkages between terrestrial and marine ecosystems. Results from this analysis will aid in examining how the proliferation of storm water detention ponds affects the ecological condition of adjacent coastal waters in South Carolina.

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SEDIMENTARY DYNAMICS WITHIN A HYPERTIDAL SALT MARSH AND TIDAL CREEK SYSTEM

A resurgence of interest in tidal power development has raised the question regarding the consequences of removing energy from the tidal environment, particularly far field changes in sedimentation. The purpose of this honour’s research was to measure flow velocity, suspended sediment concentrations and deposition, and to compare the results within a tidal creek and adjacent salt marsh in the Upper Bay of Fundy. Flow velocity and suspended sediment concentration were measured with Acoustic Doppler Velocimeters co-located with OBS (marsh) and an Acoustic Doppler Current Profiler with an RBR (creek). Sediment deposition was measured with surface mounted sediment traps. Disaggregated grain size analysis was performed on the Coulter Multisizer® 3 grain size spectrometer to determine the amount deposited in flocculated form. All data were collected during periods of spring tide. Data were collected in the tidal creek and on the salt marsh simultaneously in order for the path of the sediment to be tracked from the point of entering the creek to being deposited. Previous research has shown that spring tides result in more deposition than neap tides in this area. Anticipated results are that the reason for spring tides having higher deposition is flocculation of sediments and inundation time. It was also anticipated that there would be more deposition in the creek than in the marsh likely associated with higher flocculation in the creek; and that higher amounts of suspended sediment concentrations available and longer inundation time would result in more deposition. The results of this research will provide empirical data for sediment transport models currently being developed in the region to assess the potential effects of energy extraction due to tidal power.
Estimates of enterococci concentration were created using a suite of statistical modeling techniques and data from state beach program, radar-based rainfall, and coastal and ocean observing system sources. Existing decision tools had been developed using rainfall data from a network of rain gauges. It was envisioned that improvements to predictions could be achieved using radar-based rainfall estimates which could be spatially and temporally averaged over watershed boundaries. It was further envisioned that coastal and ocean observing system data could be used to replace key model parameters that were manually collected (e.g., salinity). If these models were successfully validated, a fully automated decision tool could be developed that did not rely on data that were manually collected by program staff. We developed a database and data management infrastructure to automate data integration from the rain gauge network, Next Generation Radar (NEXRAD) rainfall, and ocean observing system components at or near the Myrtle Beach, SC coast. We evaluated three sets of predictive models based on integration of data from these data sources. Initial results suggest that integration of radar-based rainfall averages over watersheds allows improved enterococci predictions, but that observing system data do not currently provide significant improvements, likely because of the spatial resolution of data provided, especially salinity. In the models evaluated, salinity from beach program data was the most consistently important predictor of enterococci. Improvements to the spatial resolution of coastal observing system salinity data and the inclusion of modeled estimates of salinity and currents would allow significantly improved, and fully automated prediction tools.

Following the release of the first Chesapeake Bay report card in 2006, environmental report cards have increasingly gained popularity and recognition as a public-friendly and user-friendly tool for communicating progress to the public at large. These cards have increasingly gained popularity and recognition as a public-friendly and user-friendly tool for communicating progress to the public at large. This is done in several ways: (1) by reaching consensus among participating groups and to fully develop the potential of region-specific report cards. In 2009, the Mid-Atlantic Tributary Assessment Coalition (MTAC) was formed to foster collaboration among participating groups and to fully develop the potential of region-specific environmental report cards. This is done in several ways: (1) by reaching consensus among participating groups and to fully develop the potential of region-specific environmental report cards. In 2009, the Mid-Atlantic Tributary Assessment Coalition (MTAC) was formed to foster collaboration among participating groups and to fully develop the potential of region-specific environmental report cards. In 2009, the Mid-Atlantic Tributary Assessment Coalition (MTAC) was formed to foster collaboration among participating groups and to fully develop the potential of region-specific environmental report cards. In 2009, the Mid-Atlantic Tributary Assessment Coalition (MTAC) was formed to foster collaboration among participating groups and to fully develop the potential of region-specific environmental report cards. In 2009, the Mid-Atlantic Tributary Assessment Coalition (MTAC) was formed to foster collaboration among participating groups and to fully develop the potential of region-

BEACH MONITORING, REMOTE SENSING AND COASTAL AND OCEAN OBSERVATION SYSTEM DATA

PAERTNERING WITH WATERSHED ORGANIZATIONS TO PRODUCE TRIBUTARY-SPECIFIC REPORT CARDS

DECONSTRUCTING SEAGRASS AND WATER QUALITY DYNAMICS WITHIN THE INDIAN RIVER LAGOON FOR TMDL DEVELOPMENT

In March 2009, total maximum daily loads (TMDLs) were finalized for nine water body segments within the Indian River Lagoon (IRL), starting north of Ft. Pierce Inlet up to the northern IRL, and four WBID segments within the Banana River. The local stakeholders conducted an extensive review of the methodologies, assumptions, and models utilized in the development of the TMDLs, along with analyses of recent seagrass mapping from the area. This evaluation identified issues with the TMDLs and concluded that they are not sufficiently accurate for appropriately determining waste load allocations. Therefore, local stakeholders have identified the need to update and revise the TMDLs, utilizing more recently available additional data and considering alternate approaches. Conceptual models have been formulated as a primary step in the analytical flow path to define the paradigm under which analyses have taken place. Exploratory data analysis methods included univariate statistical analyses, cumulative distribution function plots, scatterplots, time-series plots and correlation matrices of response and potential explanatory variables. Statistical methods, including ordinary least squares and logistic regression techniques, were employed to deconstruct seagrass and water quality dynamics within the Indian River Lagoon for TMDL Development.

SEAWATER INTRUSION ALONG THE COASTLINE OF THE FLORIDA EVERGLADES AND ITS INFLUENCE ON SURFACE WATER CHEMISTRY AND ECOSYSTEM METABOLISM

Seawater intrusion along the coastline of the Florida Everglades results in brackish groundwater to discharge to the overlying seasonally-fresh, coastal wetlands. The objective of this research was to quantify the amount of groundwater discharge to the surface waters of the Taylor Slough drainage basin and to evaluate the effects of the groundwater discharge on the overlying surface water chemistry and ecosystem metabolism. Groundwater discharge to the surface water was estimated via a combination of techniques including a water balance, hydraulic gradient, temperature, and geochemical tracers. Ecosystem metabolism was estimated as daily rates of gross primary production (GPP), ecosystem respiration (R) and net ecosystem production (NPE) from free-water, diel changes in dissolved oxygen. Over the course of 2 years, brackish groundwater discharge was found to be greatest during the months of May-July. Surface water chemistry was fresh from September through February, but became brackish to hypersaline between March and July, coincident with the period of
highest brackish groundwater discharge. Phosphorus concentrations in the surface water also spiked during the months of May-June along with the magnitude of both GPP and R, while NEP was largely unchanged. The results of this research support the conclusions that surface water chemistry and ecosystem function in the coastal Everglades responds to periods of groundwater discharge.

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STRUCTURAL EQUATION MODELING APPROACH TO ASSESSING OYSTER RESTORATION AND WATER QUALITY IN THE ST LUCIE RIVER ESTUARY, SE FLORIDA

We are using structural equation modeling (SEM) to analyze water quality data from DBHYDRO (South Florida Water Management District) as part of our assessment of oyster reef restoration in the St. Lucie River estuary, in southeastern Florida. Water quality data from 2000-2011 were analyzed, since this includes years during and before the pilot restoration began (2005) and the current large scale restoration (2009). Data were first analyzed by ARIMA to determine the nature and periodicity of cycles in the time series. Then, cycles were modeled in SEM by using time lags (1 month, 6 months, etc) as necessary to account for the non-independence in time. Preliminary analyses of one water quality station indicate that the concentration of chlorophyll a, a surrogate for phytoplankton one of the Eastern Oyster’s main food sources, is a + function of temperature, and 1 month lags in salinity and ortho phosphate; and, a negative function of ammonia. Further, water quality variables (nutrients, turbidity, color, DO, total suspended solids, etc.) are modeled as functions of rainfall and canal flow (both direct and indirect paths), and salinity (as a measure of tidal water inputs). Data from a series of water quality stations in the estuary are being tested and compared to determine the extent to which important drivers differ in relative strength at different areas of the estuary. These will be linked with our biological data on oyster abundance and size, and diversity of the associated species.

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SOURCES, SINKS, AND SLOSS: METAPOPULATION DYNAMICS GUIDE THE DESIGN OF A MARINE RESERVE NETWORK

Marine reserve networks are a potentially powerful management tool for restoring depleted populations, such as eastern oyster (Crassostrea virginica), however, the design of reserve networks within the single large reserve (SLR) and several small (SLOSS) options remain under debate. We used an integrated demographic and larval connectivity of an oyster reserve network in Pamlico Sound, NC within a metapopulation framework to (1) identify source and sink reserves, (2) integrate demographics and larval connectivity of an oyster reserve network in Pamlico Sound, NC within a metapopulation framework to (1) identify source and sink reserves, (2) determine the potential for network persistence (i.e., λ = 1), and (3) evaluate the tradeoffs of increasing reserve size or number on network connectivity. Mark-recapture studies, fecundity analyses, and larval dispersal simulations were conducted to parameterize a spatially-explicit metapopulation model of the existing reserve network and assess network design strategies. The relative contribution of reserves to the network (λ_i) ranged from 0.6 to 15.1, indicating the presence of “source” and “sink” reserves. Over the four years of model simulations, the mean intrinsic growth rate of the existing reserve network (λ) was 0.7 ± 0.1, and thus, the network was not capable of persisting through time primarily due to limited network connectivity. Increasing the number of reserves by 2 and 4 times increased network connectivity by 80-90% relative to doubling or quadrupling the area of existing reserves. These results suggest that while the oyster reserve network in Pamlico Sound is not currently self-sustaining, increasing the number, as opposed to size, of reserves within the network may be a more effective strategy to improve network connectivity, and ultimately, network persistence.

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APPLICATION OF HYDRODYNAMIC MODELING TECHNIQUES TO ASSESS WATER QUALITY EFFECTS ON LOWER LAGUNA MADRE, TEXAS, SEAGRASSES

The Lower Laguna Madre (LLM) of Texas contains about half the seagrass in Texas (46,180 ha), but the seagrass composition in the LLM has changed significantly in the past 30-35 years. In 1988, Siringodium and Halodule were the most common species (25.9% and 31.9% cover, respectively). In 1998, Thalassia (16.1%) had expanded and replaced much of the Siringodium (18.6%), while Halodule had remained stable (31% cover). Qualitative decreases, especially in Halodule, have been observed in 2010. Since salinities in LLM had stabilized by the late 1970s, seagrass dynamics since 1988 represent a dramatic example of unexplained ecological changes. The cause of these changes is likely salinity fluctuations, nutrient loading, and recently, higher inflow and temperature regimes. The Arroyo Colorado (Arroyo) is the main freshwater source for the LLM and P loading from the Arroyo has been suspected as a major cause of some of the observed seagrass changes, due to its role in draining wastewater and agricultural return flows from the Rio Grande Valley to the LLM. We hypothesize that an investigation of seagrass changes in the LLM and P loads from the Arroyo Colorado is a main driver of this change through its impact on LLM water quality. In order to estimate the zone of influence from Arroyo inflows on LLM water quality, we have applied the Texas Water Development Board TxBLEND hydrodynamic, bay circulation model to visualize spatial and temporal changes in LLM salinity of the LLM-Arroyo confluence area as Arroyo inflow regimes change. Preliminary data will be presented to compare the salinity spatial patterns determined from the TxBLEND model with changes in seagrass coverage and species’ distributions. These salinity patterns would potentially reflect other water quality impacts such as dissolved nutrients.

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PHYTOPLANKTON COMMUNITY DYNAMICS IN GALVESTON BAY: IMPORTANCE OF FRESHWATER NUTRIENT AND SEDIMENT LOAD

Estuarine phytoplankton community dynamics are responsive to changes in salinity, nutrient and sediment loads from major rivers, tidal exchange with oceans, changes in circulation (ship channels, dikes) as well as land use patterns. Estuaries in Texas, like many other places, are experiencing changes in hydrology and water quality due to increased pressure as a result of greater water demands upstream and for greater ecosystem services in the main water bodies. While water rights are intended to protect estuaries, developing the appropriate criteria and metrics remains a major challenge for scientists and resource managers. Herein, we present findings of efforts (2008-present) to use phytoplankton as bioindicators for estuary health in Galveston Bay (Texas). The work focused on the importance of freshwater nutrient and sediment loads in defining phytoplankton community composition, abundance and response. We examined the response of phytoplankton to both natural inputs from the major rivers as well as under experimental manipulation (resource limitation assays). We found that phytoplankton were often nitrogen-limited and/or nitrogen and phosphate co-limited but never silicate limited. Further, phytoplankton were more light limited in the northern section of the Bay (closer to the river mouths) than in the southern section of the Bay. Bulk changes in phytoplankton community composition were driven by seasonal patterns more strongly than nutrient and sediment loads. Antecedent conditions need to be considered in developing predictive models. Our findings will ultimately be used to develop detailed process-based understanding of the linkages between the magnitude and timing of freshwater inflows and phytoplankton dynamics in Galveston Bay.

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TROPHIC ECOLOGY OF THE FISH COMMUNITY IN A SUBTROPICAL COASTAL LAGOON (SE, GULF OF CALIFORNIA) DETERMINED BY STABLE ISOTOPEs

Estuarine and coastal lagoons are amongst the most productive systems at various levels, however, both are often subjected to considerable anthropogenic pressures that threaten the ecosystem integrity. In the case of the estuarine systems of the SE Gulf of California, the most important anthropogenic factor is the artisanal shrimp fishery, which is considered to cause significant damage to the environment due to the large amount of fish and invertebrates captured as bycatch. The aim of this investigation was to study the actual trophic structure of a subtropical coastal lagoon based on stable isotopes of the most abundant fish species and invertebrates (in terms of biomass and relative abundance) that were caught as bycatch by the artisanal shrimp fishery. This study was performed in one of the most important fishing grounds in the southern Gulf of California: the Santa Maria la Reforma estuarine system. Most abundant fish species during different seasons were investigated, which accounted for more than 70% of the total fish biomass and abundance. The food web is structured into five trophic levels. Most of the fish species analyzed are carnivores from trophic level 4 (45%-50%), followed by carnivores from level 3 (11%-17%) and 5 (9%-12%). Predators from level 5 are now scarce and species from level 4 do not serve as prey, and therefore, the abundance of level 4 is increased along with preying on species from levels 3 and 2 and reductions in abundance of species from these levels. The main activity is
the artisanal shrimp fishery in this system, which captures and discards a high quantity of fish as bycatch.

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SPATIO-TEMPORAL PATTERNS OF CHANGE IN MARINE BENTHIC COMMUNITIES: FULL SPECIES LEVEL ASSESSMENT VS SYNTHESIS STRUCTURAL INDICES

Synthesis indices have long been searched for and used in many scientific domains. Their purpose is to capture, preferably in a single number, the attributes of the underlying data, often multivariate. In ecology, this is almost always related to multiple species composition. Very well known examples include the primary biological indices species richness, abundance and biomass, namely for their use in the Pearson and Rosenberg SAB model, but also derived biological indices such as diversity, of which the Shannon-Wiener, the Margalef and the Sympon are well established among ecologists. The oversimplification inherent to indices has gained followers and opponents. Indices have also made their way into environmental legislative pieces, namely in the European Water Framework Directive. This has raised the major challenge of deriving synthesis indices capable of portraying the ecological quality of inland, transitional and marine waters. Such indices need of course proper testing and validation procedures. Very rarely, we see them used under hypothesis testing scenarios. In this study, we make such an attempt and follow the spatio-temporal trajectory of change of near shore benthic communities submitted to sewage outfall organic enrichment. The study encompasses 10 years, the first of which is before the operation of the outfall. Samples were placed in five belts at increasing distance to the outfall and visited annually. Areas were treated as a fixed factor in this analysis, as well as time, with two levels, before and after the outfall operation. Sampling sites are random and nested in distance belts and in time. Of major interest in this model is the analysis of the interaction term between the spatial (belts) and the temporal (before-after operation) factors. We analyze this model taking into consideration the species and the synthesis indices data sets.

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EFFECTS OF ARTIFICIAL REEF STRUCTURES ON THE GEOLOGY AND BIOLOGY OF THE SEA FLOOR: EXAMPLE FROM THE INNER CONTINENTAL SHELF OFF DELAWARE

The influence of large objects on the surface geology and biology of the seafloor has implications for marine spatial planning and coastal development, including use of the coastal zone for offshore wind energy. We present results of seafloor surficial geology and habitat mapping of the Redbird artificial reef site, located on the continental shelf offshore of Delaware. Redbird reef is composed of NYC subway cars, barges, tugboats, and other sunken objects. Objects have been added periodically between 1997 and 2009, thus providing a natural laboratory to study the evolution of the structural reef habitat through time. In August 2010 we used a 500 kHz phase-mapping bathymetric sonar to collect bathymetric and backscatter data at the Redbird. Additionally, 500 kHz side-scan surveys of the site occurred annually between 2008-2010. Seafloor classification program QTC SWATHVIEW was used to determine area coverage of each bottom type. ROV video and grab samples ground-truthed our acoustic classifications. Clear sediment and biological patterns emerged revealing the influence of the objects on the seafloor: A silty, clayey sand covered areas remote from the objects and a gravelly sand surrounded the objects. The abundances and diversity of organisms increased with decreasing clay/silt content. The structural reef habitats were completely encrusted in organisms including sea whips, sea stars, star coral, and encrusting bryozoans. The surrounding gravelly sand had numerous sea stars, hermit crab, and surf clam. The silty, clayey sand had fewer hermit crab and sea star. Evidence of scour included the removal of fine sediments and the formation of motes 12-30 m in diameter and 0.5-1 m deep around the reef objects. Altogether the 0.25 m backscatter mosaics, 0.5 m bathymetric grids, and 1 m classified maps provide detailed information about the evolution of geology and associated biology of the seafloor in the vicinity of reef objects.

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EVALUATING MACROBENTHIC INDICATORS WITHIN THE COASTAL MISSISSIPPI HYPOXIC ZONE

Macrobenthic communities provide effective indicators of biotic integrity. However, because many coastal taxa are eurytolerant, they can be problematic for discerning anthropogenic stress. Effective coastal management calls for indicators that relate to specific stressors, apply across different habitats and regions, and convey ecosystem function. Organic enrichment followed by hypoxia engenders depauperate macrobenthic communities largely composed of small short-lived opportunistic organisms. Thus, macrobenthic process indicators based on body-size descriptors should respond to eutrophication. Coastal Mississippi experienced widespread and sustained hypoxia throughout the summer of 2008. The overarching objective of this study was to examine how macrobenthic condition may have been impeded by hypoxia within the study area. Two sites located on the 10-m and 20-m isobaths within the 2008 hypoxic zone served as the focal area for a case study of the effects of hypoxia on the benthic macrofauna. Another site at 20 m depth located outside the hypoxic zone in July 2008 served as a reference spatial. Benthic samples were taken prior to the onset of hypoxia, during hypoxia, and for two years following the 2008 hypoxic event. The macrobenthos shifted from a mature diverse assemblage containing large and long lived organisms to a depauperate assemblage. Macrobenthic process indicators comprised production potential, faunal turnover rate, mean body size, total biomass, total abundance, and the normalized biomass size-spectrum. Overall, the process indicators reflect community maturity and secondary production as independent responses. Consideration of the roles of macrobenthic constituents revealed a balance between equilibrium, opportunistic, and tolerant taxa relative to hypoxic effects. Tolerant taxa played a mediating role, as revealed by their adaptations to hypoxic conditions.

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SEDIMENT FLUX AND LATERAL EXCHANGE IN AN ESTUARINE TURBIDITY MAXIMUM

An estuarine turbidity maximum (ETM) is often found at the upper limit of the salinity intrusion, where baroclinic convergence and increased stratification enhance trapping of suspended sediment and create locally elevated sediment concentrations. The processes that create the ETM are sensitive to water depth, and therefore strong lateral gradients in suspended sediment concentrations can develop between a deeper channel and adjacent shoals. The channel-shoal bathymetry is common, and differences in trapping across the depth transition may be central to the mechanics of suspended sediment flux through the ETM. In this study we combine field observations and a numerical model to evaluate sediment dynamics in an ETM of the upper Hudson River estuary. Frontal trapping associated with a width constriction at a headland produced high sediment concentrations (~200 mg/L) in the channel, with net landward fluxes that were strongest during neap tides. In contrast, sediment concentrations on the shoals were lower (~50 mg/L) and net fluxes were down-shoal, increasing in magnitude during spring tides. We examine the lateral transport processes that move sediment trapped in the channel out onto the shoals, including how the 3-d structure of the salinity front creates lateral bathymetric gradients and depends on channel curvature. We compare conditions in the upper Hudson with the ETM in the lower estuary that has been intensively studied previously. The shoals at the upper ETM are broad and shallow compared with the more constrained lower Hudson, and we evaluate how the difference in lateral bathymetry between the two regions affects sediment trapping efficiency.

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CHENER PLAIN COASTAL WETLAND DEVELOPMENT IN SOUTHWEST LOUISIANA: POSSIBLE LINK TO DOWNSTREAM SEDIMENTATION FROM INCREASED ATCHAFALAYA RIVER FLOW AND STORM DEPOSITS

In southwest Louisiana, the Chenier Plain offers an ideal study site for the interaction of climate change, coastal oceanography, fluvial geomorphology, sedimentology, and effects of human activity on shoreline processes. The Chenier Plain is a microtidal, storm-dominated coastal environment situated west and downdrift of the Mississippi River Delta (MRD). A combination of the Mississippi River’s switching course – once per 1000 years, storm-driven sedimentation, and changing sea level formed the Chenier Plain’s system of alternating marsh, barrier island, and sandy-shelly elevations (“chenier” or “oak”) ridges. To date, the sediment pathways for Chenier Plain interior wetland development are not well understood. They also differ from the MRD land-building process where sediment settles out and accretes to form wetlands when the Mississippi River reaches the open ocean and decreases in velocity. In response, five 2m sediment cores were collected from Miller Lake, a Chenier Plain coastal lake. Historic photos and maps demonstrate marsh formation in Miller Lake during recent decades. Grain size analysis shows an increasing frequency of possible storm deposits in the
top 25cm of the cores. A Pb-210 geochronology from the most nearshore core indicates that sedimentation increased after ~1970, which is nearly contemporaneous with the delta development at the Wax Lake and Atchafalaya River Deltas. An increased flow in the Atchafalaya River from the Mississippi River that occurred in the mid-20th century may be producing increased sediment concentrations nearshore of the Chenier Plain. This study suggests that interior wetland development is likely associated with a regime of downdrift sedimentation from increased river flow and high energy event sediment re-suspension and deposition. Further research on sediment transport to wetland development in the Chenier Plain may offer insight on possible coastal restoration solutions.

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**A BENTHIC RESPONSE INDEX TO ASSESS BENTHIC COMMUNITY CONDITION IN THE TIDAL FRESHWATER SACRAMENTO-SAN JOAQUIN DELTA REGION OF THE SAN FRANCISCO ESTUARY**

Evaluating environmental condition based on benthic community composition is a cornerstone of many marine monitoring programs. Although there are many examples of benthic indices for saline subtidal sediments, few examples of regional benthic assessment methods exist for tidal freshwater habitats. This reflects the difficulty of assessing environments where natural stress is likely high due to variations in salinity and flow, potentially resulting in low signal to noise ratios. A Benthic Response Index (BRI) was developed for the Sacramento-San Joaquin Delta region of the San Francisco Estuary based on a disturbance gradient with end members defined by benthic ecologists using best professional judgment. These sites provided clear separation of “good” and “bad” conditions in the 988 sample multivariate ordination space, without being confounded by habitat factors. Identifiable biological properties explained the disturbance gradient vector. “Good” sites were dominated by molluscs and amphipods, with low BRI tolerance scores for amphipods common in undisturbed areas such as *Americorophium spinicornes, A. stimpsoni*, and *Gammarius dabiens*. “Bad” sites were dominated by oligochaetes, with high tolerance scores for Limnodrilus hoffmeisteri, L. udikumensis, Aulodrilus pugiuti, and Dero digitata. The AZTI Marine Biotic Index (AMBI) approach was used as confirmation of species differences among “good” and “bad” sites. This study suggests that a BRI can be developed for the tidal-fresh environments. However, additional studies to (1) validate the BRI using independent data, (2) develop assessment thresholds, and (3) validate assessment thresholds with delta using experiments or natural gradients are necessary before an assessment method is finalized.

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**EVALUATION OF THE VERTICAL STRUCTURE OF A VARIETY OF MATERIALS USED TO RESTORE INTERTIDAL OYSTER REEFS IN GEORGIA**

The complex vertical structure of oyster reefs provides settlement sites for oyster spat, habitat and refuge for small estuarine animals, and structure that can alter sedimentation. Different materials used to restore oyster reefs, such as shell bags, oyster bundles, and rip-rap have inherently different structures. The purpose of this study was to determine whether the vertical structure of intertidal oyster reefs restored using a variety of materials differs after oysters settle and grow over the underlying materials. Reef vertical structure was characterized using rugosity and the maximum height of vertical surfaces at three adjacent restoration types at Skidaway Island, Georgia; reefs with shell bags place on widely-spaced shipping pallets (~1 to 2 m apart), reefs with closely-spaced pallets (~15 cm apart), and reefs with adjacent pallets. Rugosity was measured by placing a 200 cm metal-linked chain along the vertical and horizontal surfaces of the reef and measuring the horizontal distance covered. The height of the tallest vertical surface along the chain used for rugosity was measured using a ruler. Percent cover of live and dead oysters, barnacles, bare mud, and marsh grasses was also recorded in 1 m^2 quadrats to determine the effects of vertical structure on reef biology. Data were collected along 3 transects at each of several restored reefs that were constructed with a variety of materials. Preliminary results suggest that there was little difference in rugosity (174 ± 5 cm to 188 ± 1 cm) among restoration types, but that the height of vertical surfaces was significantly greater for reefs with widely-spaced pallets (40 ± 1 cm) as compared to closely-spaced (10 ± 2 cm) and adjacent pallets (6 ± 1 cm), leading to lower sedimentation between the widely-spaced pallets. These preliminary results suggest that the structure of the underlying materials is likely to impact the outcomes of oyster restoration projects.

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**EFFECTIVE STRATEGIES TO MANAGE DREDGE RELATED THREATS TO TROPICAL SEAGRASS SYSTEMS BASED ON SEAGRASS ECOLOGICAL REQUIREMENTS**

Major dredging projects have the potential to impact on tropical seagrass communities through direct removal and burial and indirectly through turbid plume deposition reducing the amount of light available to seagrasses. This is a major concern in Australia and elsewhere in the Indo Pacific region where substantial expansion of tropical ports associated with the resources boom is occurring. In the majority of cases managing the impacts from turbid plumes has focussed on a turbidity threshold that has not been related to the true light requirements of the various seagrass species potentially impacted. Here we report on the value of an approach based on determining the minimum light requirements of species, their resilience to impacts and ability to recover and designing a dredge mitigation approach that is focussed on maintaining critical windows of light to support seagrass growth and longer term survival. Results show the value of experimentally determining locally relevant ecological requirements and the importance of understanding the relationships between light requirements, tidal exposure, shifts in spectral quality of light, seasonality and capacity for species to recover from light stress in determining ecologically relevant triggers. This information combined with a robust toolkit for assessing sub-lethal light stress provides an effective dredge mitigation strategy to protect seagrasses.

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**MODEL SIMULATIONS OF PRODUCTION AND BIOMASS OF MYTILLUS EDULIS IN THE FEHMERN BELT AREA**

In connection with an EIA of a construction of a bridge or tunnel across the Fehmern Belt, southern Baltic Sea, monitoring and modelling of the Blue mussel (*Mytilus edulis*) biomass was done independently before assessing the impact on sea ducks, particularly Common Eiders (*Somateria mollissima*) during the construction phase. The mussel population model consists of 12 size classes with shell size from 0.5-0.8 cm to 5-7.5 cm. Each size class includes number of mussels (m^-2) and ash free dry weight (g m^-2) as state variables. The net production of mussels is a function of phytoplankton concentration, temperature and oxygen in bottom water. The mussel population model is an integrated part of an eutrophication model linked to a 3 D hydraulic model (MIKE 3 FM) with triangular flexible elements covering an area of 500 m^2. Spat fall is described as sedimentation of spat on to bottom dependent of sediment bulk density, with spat having a preference for hard
Sediment types (high bulk density). Transfer of mussel biomass and numbers to a higher size class is introduced when exceeding a fixed condition index (mg cm⁻³). Mortality is introduced below a minimum condition index, by prolonged hypoxia/anoxia, by “crab and starfish” and bird (Common Eider) predation. As the mussel population initially was unknown, the biomass has been veined up by the model on 5 successive years of simulation. The model predicts an end biomass of all size classes prim November of 39540 tonnes AFDW soft tissue in Fehmern Belt. The highest biomasses are simulated west of Fehmern Island and south and west of Lolland. The modelled biomasses fit the estimated biomasses from processed monitoring data in the Belt, however the model underestimates the biomass on soft bottoms west of the Belt. The modelled distribution of biomass fits the distribution of Common Eiders in the Belt. The model system seems appropriate to assess impacts on mussel and sea duck population.

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Science and Data Needs for Effective Coastal and Marine Spatial Planning

An essential requirement for successful regional ocean governance is access to accurate and reliable information required for coastal and marine spatial planning (CMSP). The National Ocean Policy for the Stewardship of Ocean, Coasts, and Great Lakes (Executive Order 13457) calls for the development of the National Information Management System (NIMS) and Coastal and Marine Spatial Planning Portal, designed to collect the data and information sharing necessary for effective CMSP. The U.S. Department of the Interior’s (DOI) Bureau of Ocean Energy Management, Regulation and Enforcement (BOEMRE) is conducting numerous scientific investigations to support the CMSP process and provide essential information that will become part of the NIMS. Much of this research is conducted in partnership with other DOI agencies such as the Fish and Wildlife Service and U.S. Geological Survey as well as other Federal Agencies such as the National Oceanic and Atmospheric Administration. An overview of current CMSP studies will be provided including the experimental use of high definition video imagery to survey avian populations, mapping the location of deepwater coral communities, and examining the human dimensions of conflict among different groups of ocean users. These investigations will provide critical information necessary for the creation of regional coastal and marine spatial plans.

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Understanding the Technical Issues Associated with the Construction and Operation of River Diversions in the State of Louisiana

The State of Louisiana has experienced a severe loss of coastal wetlands during the past century. Much of this wetland loss has been due to the decoupling of the flow of the Mississippi River and its distributaries from the interdistributary coastal basins that resulted from the leveeing of the river in the 19th and 20th centuries for flood control and navigation purposes. The State, together with its federal partners and the academic and non-governmental community, has developed a number of plans for achieving a sustainable coastal zone. A key component of all of these strategies is to reconnect the river to the coast constructing new and operating existing diversions from the river to mimic the pre levee hydrology distribution of freshwater, nutrients and sediments to the coastal wetlands. A large number of academic studies have been conducted on the wetlands and estuaries receiving diversion flows to improve the understanding of the responses of specific ecosystem and sociocultural components of the coastal ecosystem to these diversions. As well, the State and federal governments have conducted extensive monitoring in these same systems, and have been conducting detailed studies during the project planning process to maximize project benefits and minimize potential negative outcomes. All aspects of this scientific inquiry provide critical information needed to define response to diversion operations and inform stakeholder discussions of trade-offs and management decision-making. Likewise, there are caveats and limits to extrapolation in all of these efforts that need to be explicitly defined to ensure that unjustifiable conclusions of diversion benefits or detriments are not made or perpetuated. This poster will describe some of the technical investigations and independent peer reviews that the State of Louisiana is conducting or coordinating in order to understand the benefits and risks in constructing and operating river diversions.

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Assessment of Estuarine Habitat Distribution from a Conservation Perspective

Protecting the natural value of the littoral area is considered one of the different socioeconomic issues which are taking account in a coastal management scheme. In this sense, the current European legislation on environmental conservation (Habitat Directive) establishes a network of protected areas (Natura 2000) in which all the natural habitats (including coastal and estuarine) must be managed trying to preserve their favourable conservation status from a socioeconomic perspective. To achieve this goal, most of the current methodologies used for this type of assessment incorporate an evaluation of the habitat distribution, however from a qualitative approach. In this work we present an objective and quantitative methodology that has been implemented to assess the habitat distribution range, within the conservation status evaluation, in the estuarine areas of Cantabria in northern Spain. The methodology takes an estuarine physical segmentation as a starting point, with the aim to identify homogeneous spatial areas to define the reference conditions. Based in that, a statistical approach is applied to recognize the optimal distribution boundaries of each habitat. This methodology has been applied to three habitats included in the Habitat Directive: i) Mudflats not covered by seawater at low tide (code 1140); ii) Atlantic salt meadows (Glano-Puccinellietalia maritimae) (code 1330); and iii) Tidal marshes (Atlantic halophophilous sedge meadows) (code 1420). A disparity status has been obtained for each habitat. Thus, while the habitat 1330 shows an optimal distribution in all the evaluated estuaries, the habitat 1140 is poorly represented in the biggest Cantabrian estuary. Finally, based on the obtained results, specific managed measures have been proposed for the improvement of those disturbed habitats.

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Acoustic Tracking of Migratory Fishes in the Bay of Fundy’s Minas Passage and Force Turbine Demonstration Area

The Fundy Ocean Research Centre for Energy (FORC) was established in 2009 as a test centre for commercial-ready tidal in-stream energy conversion (TISEC) devices. The first commercial-scale device (OpenHydro) was deployed by Nova Scotia Power Inc during Nov 2009-Dec 2010 and will be followed by the deployment and grid connection of at least three other TISEC device types in 2012. The unique features of the upper Bay of Fundy – up to 16 m tidal range, extreme currents (up to 6 m/sec), sediment-laden ice, diverse and abundant migratory fish species, some of which are transboundary migrants and “species of concern” are found in few other places in the world, and seldom together. This presentation will examine the potential risk of fish-turbine interactions and focuses on the movements of three fish species (striped bass, Atlantic sturgeon, and American eel) in the Minas Passage and FORCE demonstration area. Underwater acoustic telemetry receivers (VEMCO) were deployed in the Minas Passage (N=22) and in nearshore areas of the Minas Basin (N=9) during July-Nov 2010 to track the movements of 120 fish imprinted with VEMCO acoustic tags (V13 or V16, with pressure sensors). The main objectives were: i) to define movement patterns (path, velocity, depth, seasonality and number of passes) of tagged fishes passing through the turbine test area, and ii) detect dispersion and avoidance behaviour, if any, of tagged fishes moving in close proximity (< 500 m) of the turbine. Preliminary results indicate very high post-surgery survival, with 92% of all tagged fish detected by at least 1 receiver, 68% detected by a line of receivers stretching across the 5 km wide Minas Passage, and 28% detected by receivers within the turbine test area. The movement patterns of all three species will be reviewed. The fish tracking program for 2011 will also be presented.

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Despite many studies that show elevation increase in coastal marshes, conventional wisdom remains that coastal marshes cannot survive sea-level rise. Further many suggest availability of space for landward migration is essential and that coastal squeeze is an inevitable consequence of sea-level rise while Understory vegetation of marshes requires separate consideration of the factors influencing horizontal and vertical
change. The character of the marsh/mudflat interface and the cross-profile of the bar
intertidal both indicate the nature of lateral change. Sea-level change may alter the prevailing
geomorphic regime at the margin from stable/accretionary to erosional if wave-depth
thresholds are crossed, sediment supply is changed or becomes inadequate to fill
accommodation space, or if a shift in biota from stabilizers to destabilizers occurs. Sea-level
rise shifts the transition from subtidal to intertidal landward but biogeochemical processes
control the relative extent of marsh vs. mudflat within the intertidal. In the vertical the role
of organic and mineral material in filling accommodation space provided by sea-level rise
depends not only on vegetative vigor and sediment supply, but also on processes such as
consolidation, and local factors such as root structure and sediment type. In many estuaries,
episodic flooding from either river or coastal storms provides a temporary increase in
accommodation space that, if sediment supply is adequate, can result in vertical fill beyond
that associated with normal flooding events. Setting marsh restoration a watershed context is
more than anticipating where sea-level rise will put the shoreline. It requires consideration of
the sediment supply and the process regimes that deliver it; the survival of the marsh
vegetation and the biotic processes mediating adjacent mudflat stability. In many areas
watershed management and local changes may be more of a threat to marshes than sea-level
rise.

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SEASONAL WETLAND HYDROLOGY DRIVES PREDATOR AND PREY CO-OCCURRENCE IN A SUBTROPICAL ESTUARY: IMPLICATIONS FOR PREDATOR-PREY INTERACTIONS AND TROPIC DYNAMICS

The species composition of ecological communities reflects interactions among organisms as
well as between organisms and their abiotic landscapes. At small spatiotemporal scales, abiotic
conditions influence patterns of species movement and habitat use. At larger scales, they
affect patterns of species abundance and distribution. Further, abiotic conditions
influence the strength and outcome of species interactions, with consequences across
multiple ecological scales. The structuring effect of abiotic conditions may be particularly
important along ecotonal gradients. In southern Florida, mangrove-lined creeks link
freshwater marshes to estuarine habitats. I examined the spatiotemporal dynamics of fish
communities along the upper Shark River in Everglades National Park. Ten sites were
sampled repeatedly across seasons (2004-2011) with electrofishing to examine the response
of mangrove and marsh fishes (predators and prey) to hydrological drivers (marsh water
levels and salinity). Fish abundance varied markedly seasonally, and was negatively related
to marsh water levels. Marsh fishes moved into the estuary in the dry season, locally
increasing prey and predator abundance, but limited to the upper area, perhaps by salinity.
Marine/estuarine predators move up the estuary matching prey increases, but appear limited by
oxygen levels. These data indicate that ecotonal creeks may serve as important dry-
season refugia for freshwater taxa, and that pulses of freshwater taxa into tidal creeks may
 tropically link estuarine and marsh habitats. Furthermore, the nature and strength of these
linkages appear to be affected by how species and functional groups (i.e., estuarine or marsh,
predator or prey) respond spatially and temporally to abiotic conditions. Increases in
freshwater inflows related to restoration efforts may affect this linkage by prolonging the
pooling of freshwater in upland marshes and changing abiotic conditions at the ecotone.

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THE CHESAPEAKE BAY AND THE MILITARY LEADING BY EXAMPLE AND MAKING A DIFFERENCE IN BAY QUALITY

Executive Order 13508, “Chesapeake Bay Protection and Restoration” requires all Federal
Agency facilities in the Chesapeake Bay watershed to cooperate in the protection and
restoration of the Bay. Given that the U.S. Military are the largest land managers and that
they also manage some of the largest contiguous land areas in the Chesapeake Bay
watershed, the DoD is in a unique position to not only lead by example but also make land
use changes and sustainability decisions that truly impact the quality of the Chesapeake Bay.
Take for example, the Army Chesapeake Bay Strategy signed in July 2009. As its part in the
larger Chesapeake Bay federal Strategy, the Army Plan set five goals and numerous actions
with specific dates for execution. For example, Goal 3, Foster Chesapeake Bay stewardship,
includes actions requiring Army installations in FY09 to “…host an event that allows public
access and incorporates Chesapeake Bay education and outreach materials.” Twelve (12)
installations hosted more than 27 events with a combined attendance exceeding 61,639.
However, leading by example is not the only area where the Army is making a
difference. The largest land holding installations in the Bay watershed have begun to develop
nutrition management plans, identified their potential to fail to meet TMDL goals, installed
more than $8.4 million in water pollution control technology, inventoried more than 692
miles of streams on installation; initiated more than 27 projects to restore or enhance riparian
zones; stabilized more than 22 miles of shorelines. This presentation will describe military
progress towards meeting FY10 actions and the goals and discuss the significance of their
actions in the Chesapeake Bay.

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IMPACTS OF INFLOW AND WAVE RESUSPENSION ON SUSPENDED SEDIMENT CONCENTRATION IN DEWATERED ESTUARIES OF TEXAS

Suspended sediments carried to estuaries by freshwater inflows, ocean exchanges, and
resuspension by waves are an integral part of estuarine systems. They contribute to processes
such as formation and vertical accretion of subtidal and intertidal habitats, nutrient transport,
pollutant transport, and light attenuation. Texas estuaries are 2- to 4-m deep and exist in a
climatic gradient with wetter conditions to the north and drier to the south. Using the Texas
Commission on Environmental Quality’s (TCEQ) Surface Water Quality Monitoring
database, average conditions across space and time of suspended sediment concentrations as
derived from total suspended sediment (TSS) measurements were computed for the period
2000 to 2010 in the three major estuaries of the Texas coast. Average TSS increases from
north to south from 32.2 to 38.6 to 41.5 mg/l for Galveston, Matagorda, and Corpus Christi
Bays, respectively. Average annual freshwater inflow, which contributes suspended
sediments, normalized by bay volume decreases 10 fold from north to south as measured
during the 2000 to 2010 time period. On the other hand, average wave energy derived from
wind time series and a simple wave model increases 2 fold from north to south, the same
trend as average TSS. Because fetch is similar in the three bays, this wave-energy trend is
caused by higher wind speeds to the south. Marine sediment input is thought to be relatively
small owing to the microtidal setting of all the bays (10-30 cm tide range in the bays).
Resuspension by waves, therefore, appears to be the primary driver of TSS in these shallow-
water bodies with freshwater inflow playing a less important role. This finding suggest that
the down-estuary intertidal depositional environments in windy Corpus Christi Bay may
receive more suspended sediment for vertical accretion than in similar settings in the
other bays. This would help counteract the drowning of marshes as sea level rises.

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CONCEPTUAL MODELING FOR RESOURCE MANAGEMENT AND RISK ASSESSMENT IN COASTAL AREAS

The growing interest in integrated assessment as a means of identifying environmental risks
and development management strategies has amplified the need to combine scientific, social
and economic information with management goals into a framework that can be used to make
fully integrated environmental assessments, forecasts, and management decisions.
Conceptual modeling methods such as Conceptual Ecosystem Models (CEMs) and
Combined Ecological-Socialial Systems Models (CESSMs) provide resource managers with
valuable tools for linking scientific and social information in a form useful for evaluating
cause-effect relationships and potential risks in an ecosystem. CEMs link anthropogenic and
non-anthropogenic drivers and their associated stressors to valued ecosystem components in
key habitats. CESSMs build upon the CEM methodology by including human services and
feedbacks as an explicit part of the system. The CESSM model has the potential to more
clearly link human activities not only to significant ecological impacts within a habitat, but
to possible social and economic impacts on human services including feedbacks upon the
initiating drivers. The resulting models can be utilized without modification for informing
resource management decisions and directing future research, narrowed and analyzed using
fuzzy logic approaches, or developed as the starting point for the Integrated Assessment and
Ecosystem Management Protocol, a process that allows managers to move from the
conceptual models through a series of scenario and options analyses to an implemented
resource management decision.

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GENETIC STRUCTURE OF THE MANGROVES RHizophORA MANGLE AND LAGUncULARIA RAcEMOSA IN FLORIDA AND THE CARIBBEAN

Mangroves are critical foundation species along tropical and subtropical Caribbean and
Florida coasts. They support diverse terrestrial and marine communities, mitigate erosion,
and in some cases are capable of forming peat at a rate great enough to keep up with annual
sea level rise. Because of these benefits, most New World countries are developing adaptive
management plans to conserve and restore mangrove forests. One essential but often
overlooked aspect in the development of successful management strategies is the consideration of the genetic population structure. Rhizopora mangle and Laguncularia racemosa are two dominant mangrove species that occur throughout the Caribbean and Florida. The objectives of this study are to characterize the genetic structure of Rhizophora and Laguncularia relative to 1) the role of two alternative pathways for propagule dispersal between populations in the Virgin Islands (VI) and Florida (FL); and 2) propagule size. Our two alternative pathways for propagule flow are based on transport of propagules either a Northern “Minor Current” pathway with islands acting as “stepping stones” resulting in FL populations being more closely related to VI than between Central America or a Southern “Major Current” pathway along the coast of Central America, resulting in FL being more closely related to Central American populations (Panama and Belize) than FL. Our comparisons of dispersal vs propagule will determine if dispersal distances vary with propagule size. We predict that genetic differentiation between VI and FL will be greater for Laguncularia which has much smaller propagules (~30X Laguncularia ~ Rhizophora) than for Rhizophora which has much larger, more buoyant propagules that can float long distances and remain viable for two years.

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MULTI-SCALE EVALUATION OF LINKAGES OF SEA-LEVEL RISE AND WATERSHED INPUTS IN THE VIRGINIA COASTAL RESERVE

Climate change and sea level rise pose a challenge to sustainable development and management of coastal ecosystems as their interactions are complex and non-linear. This two-pronged impact is even more relevant in areas like the coastal lagoons of the Virginia Coast Reserve (VCR) because it is experiencing high rates of the sea level rise (about 3.16 mm/yr) and this area presents a vast extension of low-lying lands highly susceptible to changes in precipitation and storm events. Areas of the VCR will experience increased flooding, erosion, loss of wetlands and low-lying terrestrial ecosystems, and seawater intrusion. Traditional statistical extrapolations and GIS analysis provide limited assessments as predicted trends deviate from increased management activities, and changes in the frequency of climate events. A better approach is the use of biophysical habitat models based on the fact that habitat changes and wetland flooding due to increased rates of sea level rise are driven by long-term and complex physical and biological processes at different temporal and spatial scales. We present a multiple-scale biophysical model to assess the effects of long-term watershed changes and sea-level rise on habitat condition under present environmental and future global warming scenarios. We examined how historical climate changes have affected coastal areas and developed a coupled hydrodynamic and habitat watershed model to examine the response of coastal forest and marsh vegetation along the coast of the VCR to increased storm frequency and intensity, variable watershed inputs, and increased rate of sea-level rise. This model establishes an explicit connection between wetland habitat distributions in the coastal lagoons of Virginia and environmental inputs. This model serves as basis for evaluating the efficacy of biophysical models for predicting the distribution and abundance of coastal habitats and will be a critical step to estimate future biodiversity patterns.

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HIGH EELGRASS GENETIC DIVERSITY IN VIRGINIA IS A RESULT OF DISTURBANCE AND RESTORATION USING SEED

Aquatic vegetation restoration has been a goal of many coastal restoration projects. However, the success of restoration efforts depends on the presence of genetically diverse propagules and the ability to effectively disperse propagules to suitable habitats. This study examines the genetic diversity of the eelgrass Zostera marina in a restoration site in the Virginia Coast Reserve (VCR) coastal bay system. Genetic diversity in eelgrass populations is influenced by a combination of dispersal and local reproduction. The VCR has a long history of coastal restoration efforts and it is critical to understand the genetic diversity of eelgrass populations in this region. Our objectives were to determine the genetic diversity of eelgrass populations in the VCR and to evaluate the effectiveness of restoration efforts using both seed and seedling restoration methods.

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FORECASTING NUTRIENT LOADING CHANGES TO ESTUARIES FROM AN ECOSYSTEM RESTORATION PROJECT

The magnitude, timing and distribution of freshwater inflow to the St. Lucie River Estuary (SLE) and the Caloosahatchee River Estuary (CREE) have been disrupted by anthropogenic alterations throughout Southern Florida history. These include over drainage of coastal watersheds and artificial connections to Lake Okeechobee (LO). This has affected nutrient levels as well as the relative availability of nutrients. Comprehensive Everglades Restoration Program (CERP) projects are proposed to achieve a more ecologically suitable pattern of freshwater inflow to these systems that will optimize nutrient loads and availability. Everglades seagrass community restoration is one of the goals of CERP, and nutrient data can be used to forecast this. The “Redfield ratio” facilitates understanding of nutrient dynamics and serves as an indicator of the relative availability of nutrients in estuarine plant communities, such as seagrasses, macroalgae and phytoplankton. An idealized succession of phytoplankton to Thalassia spp. occurs from Redfield gradients of 16 to 30, and Redfields above 30 create phosphorus limitation of seagrasses. SFWMD data shows that regulatory releases from LO provide significant loads to the SLE and CREE, with Redfield ratios of 23.4 for SLE and 53.7 for CREE. The construction and operation of CERP will affect these nutrient loads. Conceptual ecological models require further development in order to use the South Florida Water Management Model (SFWMM) output to evaluate restoration effects. For this reason, CERP regional evaluations and other forecasting techniques have not employed these models. This poses a dilemma as the ecological effects of CERP cannot be examined in regional evaluations. This created a system that was operated for flood control and water supply purposes at the expense of these estuaries. Flows and loads to the estuary varied dramatically and the salinity regime was no longer compatible for the restoration efforts. This resulted in a dramatic decline in these ecosystem components. Today only remnants of the estuaries and SAV beds remain in these estuaries. The Comprehensive Everglades Restoration Program (CERP) was inaugurated in 2000 to correct some of these problems and operate the estuary in an ecologically sustainable fashion. This resulted in the planning and design of a series of reservoirs in the Caloosahatchee River, C-44, Kissimmee, and Saint Lucie River Basins. CERP also inaugurated a monitoring program for baseline testing to provide feedback to the designs and relationships of these estuarine systems. The Reconnaissance Coordination and Verification(RECOVER) would apply adaptive management principles to CERP.

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SEEQUENTIAL STORM EFFECTS ON BARRIER ISLAND MORPHOLOGY: DATA AND MODELING ANALYSES

Two sequential storm events, Tropical Storm Hanna in early September 2008 followed by a nor’easter in late September 2008 had similar wave characteristics, yet produced different

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SEQUENTIAL STORM EFFECTS ON BARRIER ISLAND MORPHOLOGY: DATA AND MODELING ANALYSES

Two sequential storm events, Tropical Storm Hanna in early September 2008 followed by a nor’easter in late September 2008 had similar wave characteristics, yet produced different generalities.
responses to the morphology of Onslow Beach, NC. Wave, water level and velocity information from a bottom mounted Nortek AWAC in 8m of water and approximately 600m from shore, two NOAA wave buoys and two NOAA tide gauges within Onslow Bay, NC were used to understand the temporal and spatial variability of the hydrodynamics within the region during these events. Slightly higher significant wave heights were recorded with Tropical Storm Hanna, but lasted less than a day and produced no overwash on the barrier island. The closest barrier island site produced overwash at the barrier island. These initial responses were, in part, due to the variations in the underlying tidal and subtidal signatures during the storm events. In addition to the analyses, these data were used to validate a coupled hydrodynamic and waves model, ADCIRC+SWAN, to better understand the spatial variability in waves, water level, and velocity along Onslow Beach. The model did a good job of replicating water level and wave height conditions at the AWAC and NOAA wave buoy and tide gauge locations. The model results indicated several focus locations with higher than average significant wave heights that may be due to bathymetric variability along the barrier island.

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INDIAN RIVER LAGOON MEIOBENTHIC COEPODE ABUNDANCE AND BIODIVERSITY NEAR THE MOUTH OF THE ST. LUCIE RIVER ESTUARY

Meiobenthic harpacticoid copepod abundance and diversity were compared among three sites that differ in impact from freshwater releases from an inland lake. These releases over time from Lake Okeechobee increase soft sediments and lower the salinity in the coastal Indian River Lagoon. Understanding the effects of the releases on the benthos may assist managers in planning the timing and duration of freshwater inputs to minimize impacts. Copepod abundance ranged from 60 to 413 in the cores and from 7 to 126 in the core water. The site furthest away from the mouth of the river and considered to be the most pristine did have the highest summer abundance (322), but the lowest winter abundance (106). The site between the river and ocean inlet had a mix of species at both times of the year, with increasing abundance from summer (184) to winter (304). The site closest to the mouth of the river and presumed to be the most disturbed had comparable abundances in summer (183) and winter (226) comprised mainly of Longipedia americana (59% in summer, 31% in winter). Longipedia americana has been described as an emergent species, which allows it to disperse in limited geographic areas. However, L. americana has not been previously noted in such high abundance in benthic core samples in other estuarine or coastal systems. Due to the shifting densities among the sites, L. americana does not appear to have a seasonal pattern. The high abundance in the sediment and core water at the most disturbed location at both times of the year and in the sediment at the other sites in the winter may indicate that L. americana is an opportunistic species in the Indian River Lagoon.

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LINKING LOCAL AND REGIONAL LAND USE WITH ABUNDANCE AND COMPOSITION OF FISH IN PUGET SOUND’S PELAGIC ZONE

Recent declines in pelagic fish species such as herring and alterations in coastal foodwebs have raised the question of how people affect the pelagic ecosystem. We examined how alterations to shoreline habitats and their local catchments may influence patterns in species abundance and composition by integrating landscape analysis into a broad surface trawling design across Puget Sound. We used a regression design that took advantage of spatial variation in land use and across six oceanographic sub-basins of Puget Sound and four different geomorphic landforms within these basins. Sites varied from 0% to over 80% developed, although this range varied among sub-basins. We describe the outcomes of this assessment and survey ongoing in 2011.

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INDIAN RIVER LAGOON (IRL) CLIMATE READY ESTUARIES (CRE) PROJECTS

The Indian River Lagoon National Estuary Program has received financial and technical assistance from EPA’s CRE Program to incorporate projections of accelerated rates of sea level rise into two studies: (1) investigating potential impacts to the City of Satellite Beach, an 8.8 square kilometer municipality located on the Holocene barrier island between the Atlantic Ocean and the Banana River Lagoon; and (2) the affect on the distribution and area of wetland habitats throughout the shallow lagoon-estuary. The Satellite Beach project involved a vulnerability assessment, overview of coastal issues and policy development to facilitate adaptive management and mitigation planning for coastal erosion, storm surge and sea-level rise. The City’s highest elevation is 6.1 m and is located along the Atlantic coastal dune, with approximately one-half of the City at elevation 1.8 m or less. Based on the CRE study the City will begin to experience inundation (5% landscape submergence) at 0.6 m rise in sea level, forecast to occur around 2070. Therefore, the City has about 40 years to implement a mitigation plan. The second CRE project involved technical assistance to examine IRL wetlands and applied the Sea Level Affecting Marshes Model (SLAMM) to evaluate changes in wetland habitats, associated with a Habitat Equivalency Analysis model to calculate changes in ecological services by habitat type as sea level rises. With a moderate rise in sea level, the lagoon region may anticipate an overall expansion in coastal wetlands. Although more drastic sea level rise will bring substantial overall wetland loss. SLAMM anticipates that sea level rise will result in changes in overall distribution between habitats, with significant increases in the areas of mangroves and tidal open water and losses of swamps and irregularly flooded salt marshes.

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POPULATION ECOLOGY OF THE EPHTHYTIC FORAMINIFERAN SORITES DOMINICENSIS IN THE INDIAN RIVER LAGOON, FLORIDA

The endosymbiotic-bearing foraminiferan Sorites dominicensis lives attached to blades of the seagrass Thalassia testudinum in the southern region of the Indian River Lagoon, Florida. The population ecology of S. dominicensis living in a seagrass meadow in Jupiter Sound was investigated in 2003-2004, 2008-2009, and is currently being studied in 2011. Population densities are highest from May through August, and lowest in January and February. Reproduction is predominantly asexual, occurring by multiple fission, with most of the parental cytoplasm used to form the embryos. The single-chambered embryos form within specialized brood chambers of the parental test. At the Jupiter site, the number of embryos produced per parent test ranges from 40 to 192. Survivorship curves generated from static life history tables show that this species is characterized by Type I survivorship, in which survival is highest in juvenile and pre-reproductive stages. The dinoflagellate symbionts are transmitted vertically from parent to offspring. Symbiont bleaching is commonly observed in July and August, particularly after extreme low tides that occur during midday, and during which the intertidal regions of the seagrass bed are subaerially exposed. The Jupiter Sound populations of S. dominicensis were decimated by Hurricanes Jeanne and Frances in September 2004, and Wilma in 2005, after which individuals of S. dominicensis were not present in any samples collected until summer 2007.

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THE CONTRIBUTION OF BENTHIC NUTRIENT REGENERATION TO PRIMARY PRODUCTION IN A SHALLOW EUTROPHIC ESTUARY, WEEKS BAY, ALABAMA

Benthic oxygen, nitrogen and nutrients fluxes (NH4+, NO3-, and PO43-) were measured monthly during a 1 yr period at two locations in Weeks Bay; a shallow (1.4 m) and eutrophic estuary in Alabama. Gross primary productivity, ecosystem respiration and net ecosystem metabolism were determined from high frequency dissolved oxygen measurements. Maxima in water column NO3-(55 μM) and chlorophyll a (138 μg/l) concentrations were measured during spring and fall, respectively. Sediments were a net source of NH4+ (102 μmol m-2 hr-1) and PO43- (0.9 μmol m-2 hr-1) but a sink for NO3- (-30 μmol m-2 hr-1). Benthic N2 fluxes indicated net N fixation (12 μmol m-2 hr-1) but a sink for NO3- (-30 μmol m-2 hr-1). Benthic regeneration supplied, on average, 7.5% and 4% of primary productivity N and P demands, respectively. These results contrast with the conventional view that benthic regeneration accounts for a large fraction of phytoplankton nutrient demand in shallow estuaries. The dominance of water column respiration in Weeks Bay is consistent with the hypothesis that in this 1.4 m deep estuary resuspension events are leading to a higher fraction of labile organic matter being remineralized in the water column. Thus, in this eutrophic estuary, rates of R are high, but the benthos makes a minor contribution to the overall nutrient regeneration and nutrient removal via denitrification.

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MANGROVE WETLAND PRODUCTIVITY AND VULNERABILITY IN MEXICO: CURRENT TRENDS IN CONSERVATION AND MANAGEMENT IN THE CONTEXT OF GLOBAL CHANGE

Mangrove wetlands are among the most rapidly changing landscapes in the Americas, with strong impacts on regional, continental and global biodiversity and biogeochemistry. Despite significant social and ecological research on changes in these ecosystems, much remains unknown about the complex and geographically differentiated drivers of mangrove use and losses. Mexico has 5.4 % (7,706 km2) of the total global area and occupies second place in the extension in the new world after Brazil (9,626.8 km2). Despite this small area, mangroves are one of the most productive Mexican ecosystems sustaining a high biodiversity and providing key ecological services. The wide range of climates and complex geomorphology in Mexico has enabled the development of highly productive mangrove forests (520-1822 dwg m-2 y-1) in a wide array of geomorphological settings influenced by local resources and regulators (e.g. salinity) gradients and hydroperiod. Using recent acquired remote sensing data for both the Pacific and Gulf of Mexico (GOM) coasts, we determine mangrove productivity patterns along hydrological gradients; from river-dominated deltas to scrub mangrove forests in karstic semi-arid regions. Since the differential availability of mangrove goods and services across the different types of mangroves is strongly associated to where mangroves grow and develop, we correlated coastal landform and ecological function to identify regional drivers controlling multiple ecosystems services. We use a hierarchical analysis where observed biomass and productivity patterns are partitioned at the latitudinal and ecogeomorphic scales for the Pacific and GOM coasts. Then, structural and productivity patterns from representative ecogeomorphic settings are integrated in a multivariable analysis to identify human and natural disturbances controlling observed mangrove distribution and rank mangrove potential vulnerability as reflected by lost of suitable habitat.

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RESPONSE OF FLORIDA SHELF ECOSYSTEMS TO CLIMATE CHANGE

The U.S. Geological Survey (USGS) project, Response of Florida Shelf Ecosystems to Climate Change (FLaSH ECC), expands on an earlier mapping project on the Florida shelf and applies spatial data to understanding shelf processes and the impact of climate change and ocean acidification on Florida shelf resources. This project is part of the USGS Ocean Acidification Initiative designed to examine the effects of climate change on coastal ecosystems from the tropics to poles. Maps and models of the shelf and coast are critical for helping stakeholders define where significant decline of carbonate ecosystems, fishery habitats, and calcifying organisms are predicted to occur this century. FLaSH ECC places shelf processes in an interpretable map format, enabling the public, resource managers, and scientists, to better understand changing marine resources. As part of this multi-year study, baseline data on carbon system parameters, including pH, pCO2, total alkalinity, and dissolved inorganic carbon, are collected to examine their spatial distribution on the west Florida shelf. These parameters are used to calculate carbonate mineral saturation states, fluxes of CO2 into and out of seawater, and inorganic carbon budgets. We have also analyzed historical pH data from Florida coastal waters to determine long-term trends in seawater pH during the past 3 decades. Additionally, we have compared these data to measurements of diurnal and seasonal variation in carbon system parameters in multiple locations along the Florida coast. These data and analyses provide a regional- to local-scale assessment of the current state of the carbon system associated with coastal and shelf habitats, and the foundation to model past and future ecosystem change and adaptation. Results from this study will assist resource managers in identifying habitat areas that may be at risk from, or resilient to, the anticipated impacts of global climate change.

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DYNAMIC EFFECTS OF OCEANIC FORCING ON FLOW AND TRANSPORT IN A SUBTERRANEAN ESTUARY

Oceanic forcing, including tides and waves, leads to complex and dynamic flow and transport processes in a subterranean estuary. Variable-density numerical modeling demonstrates that tides and waves acting on a permeable sloping beach boundary drive seawater recirculation across the sediment-water interface at significant rates compared with fresh groundwater discharge. This not only alters the nearshore subsurface flow dynamics and SGD rates but also leads to the creation of a surficial salt-freshwater mixing zone and alters the landward extent of saltwater intrusion in the aquifer. Despite their higher frequency, the effect of waves on subsurface flow and salt transport is similar to that of tides as they induce an onshore upward tilt in the phase-averaged sea level (wave setup). Reactive transport simulations illustrate the influence of oceanic forcing on the transport, transformation and subsequent discharge of land-derived chemicals including nutrients and BTEX contaminants. The chemical transformations and chemical fluxes across the sediment-water interface are influenced by the magnitude of oceanic forcing relative to the fresh groundwater flow rate as this alters the intensity of salt-freshwater mixing and period of exposure of the contaminant to the mixing and reaction zone. Key factors that control the way oceanic forcing effects the functioning of a subterranean estuary will be discussed.

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ACQUISITION OF INTEGRATED, FIELD-BASED, SUBTIDAL AND INTERTIDAL MARSHLANDS MORPHOLOGY AND COMPARISON TO LIDAR DATA

A unique topographic/bathymetric elevation dataset for Groves Creek, Chatham county GA was collected in 2010 and 2011 to generate a high-accuracy DEM for use in sedimentological and hydrodynamic modeling studies. Surveys using RTK-GPS were conducted on marsh platforms, small intertidal creeks, and creek levees throughout the 142 hectare study site. Larger creeks were surveyed using a single-beam echosounder. The main channel of the creek was surveyed using a shallow-water multibeam sonar system. This combined, field-based elevation dataset was compared with a LiDAR elevation dataset collected by Chatham county to evaluate the accuracy of LiDAR data in various zones of the saltmarsh. On the marsh platform, LiDAR-derived elevations were generally in good agreement with RTK-GPS surveyed elevations (mean difference = 0.00 m, SD = 0.06 m, n=15,868). However, in creek and levee regions, LiDAR error can be significant and the distribution of the data suggests that individual flight lines in LiDAR acquisition, and their correction factors improve the accuracy of LiDAR data. A suite of plant-species-specific elevation correction factors derived from the marshes near Sapelo Island, GA, are being applied to the Groves Creek LiDAR DEM to determine if, and how effectively, the correction factors improve the accuracy of the LiDAR data.

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APPLICATION OF ACOUSTIC METHODS TO ASSESSING FISH UTILIZATION OF SUBTIDAL OYSTER REEF HABITATS IN GALVestone BAY, TEXAS

One important ecosystem service of oyster reef habitats is provision of foraging habitat to commercially and ecologically important fish species. Sampling fish assemblages on subtidal oyster reefs using traditional methods can yield valuable information on the species that utilize these habitats. Acoustic methods show great promise in extrapolating the results of traditional sampling methods over large areas. We used a bathymetric side scan sonar system and a digital scientific echo sounder to simultaneously collect information on bottom habitat type and acoustic fish biomass. Bottom habitat types were classified using QTC Impact software. Volume backscattering strength (Sv), a rough measure of fish biomass, was calculated using Echoview software. Mean volume backscattering strength (Sv), a rough measure of fish biomass, was calculated using Echoview software. Mean volume backscattering strength (Sv), a rough measure of fish biomass, was calculated using Echoview software. One important ecosystem service of oyster reef habitats is provision of foraging habitat to commercially and ecologically important fish species. Sampling fish assemblages on subtidal oyster reefs using traditional methods can yield valuable information on the species that utilize these habitats. Acoustic methods show great promise in extrapolating the results of traditional sampling methods over large areas. We used a bathymetric side scan sonar system and a digital scientific echo sounder to simultaneously collect information on bottom habitat type and acoustic fish biomass. Bottom habitat types were classified using QTC Impact software. Volume backscattering strength (Sv), a rough measure of fish biomass, was calculated using Echoview software. Mean volume backscattering strength (Sv), a rough measure of fish biomass, was calculated using Echoview software.
PREDICTING THE EFFECTS OF WATER QUALITY ON THE GROWTH OF THALASSIA TESTUDINUM IN TAMPA BAY WITH A DYNAMIC SIMILE-BASED MODEL TOOL

We describe a seagrass growth (SGG) model that is coupled to a water quality (WQ) model that includes the effects of phytoplankton (chlorophyll), colored dissolved organic matter (CDOM) and suspended solids (TSS) on water clarity. Phytoplankton growth was adjusted daily for PAR (integrated over depth) and temperature, and was bounded by cell death, nitrogen and phosphorus availability. The WQ model functions on a daily mixing cycle based on tidally averaged exchange coefficients for each of 10 bay segments. Nutrient (N and P), TSS and CDOM inputs were derived from fresh water flow from gauged and ungauged drainage basins. Ungauged flows were estimated from a hydrologic model that included rainfall and four land-use categories (urban, agriculture, wetlands and forest). Atmospheric inputs of nutrient species were also included. In the SGG model changes in seagrass biomass were determined from daily rates of photosynthetic carbon fixation, loss of carbon from respiration, and plant mortality. Seagrass growth rate was adjusted daily for day length, photosynthetically active irradiance (PAR) levels, and temperature and was bounded by biomass carrying capacity. Irradiance at plant canopy depth was adjusted for water quality parameters (e.g. phytoplankton biomass, CDOM, and TSS). Day length and PAR levels just below the surface of the water were provided by a simple spectral solar irradiance model. Future versions of the model will include sub-models linking total seagrass biomass to commercial and recreational fishery production functions. Understanding this linkage will help in estimating the value of seagrass in supporting fisheries and how land use changes can impact fishery production through changes in seagrass communities.

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RESOLVING THE RELATIVE IMPORTANCE OF FISH NURSERY HABITATS USING OTOLITH ELEMENTAL FINGERPRINTS

Quantification of the relative importance of fish nursery habitats is necessary for resource managers to effectively prioritize the conservation and restoration of these areas. Scientists are increasingly using elemental signatures contained within fish otoliths to identify nursery areas that contribute disproportionately to adult fish stocks. The chemical composition of the otolith acts as a natural tag, reflecting the occupation of different water bodies, and can be thus be used to distinguish fish from different geographic origins. To determine the relative importance of specific tidal tributaries as nursery habitats throughout Tampa Bay, Florida, USA, we are using laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) to analyze elemental fingerprints within the otoliths of two estuarine-dependent species of fish, common snook (Centropomus undecimalis) and red drum (Sciaenops ocellatus). Distance-based Canonical Discriminant Analysis applied to otolith elemental fingerprints of young-of-the-year fish from more than 30 Tampa Bay tributaries has suggested that surgical geology, anthropogenic inputs, and salinity gradients may be primary contributors to the variation in otolith chemistry among nurseries. Maximum likelihood estimation of the elemental signatures from the core portions of adult otoliths from the same cohort will enable us to identify their probable nursery areas, as defined by young-of-the-year otoliths. Overall, our classification framework has distinguished nursery regions with a resolution of approximately 20 kilometers, providing an effective tool for fine-scale management of elemental signatures from the core portions of adult otoliths from the same cohort.

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HETEROTROPHIC PROTOZOA GRAZING BEFORE, DURING AND FOLLOWING HARMFUL CYANOBACTERIA BLOOMS IN A SHALLOW, TIDALLY-INFLUENCED COLUMBIA RIVER FLOODPLAIN LAKE (VANCOUVER LAKE, WASHINGTON, USA)

We conducted bi-weekly dilution experiments from April to November in 2008 and 2009 to estimate heterotrophic protist (i.e. microzooplankton) grazing and intrinsic phytoplankton growth rates. Before, during and after filamentous cyanobacteria blooms in Vancouver Lake, WA, a shallow, tidally-influenced lake in the lower Columbia River floodplain. Intrinsic phytoplankton growth rates were usually low in April (~0.4–d–1), reached maximal rates (~1.2–d–1) in May, then declined to zero and became negative in June and early July, prior to cyanobacteria blooms dominated by Aphanizomenon flos-aquae that occurred in both late July of both 2008 and 2009. Phytoplankton growth rates rose as the blooms progressed, reaching rates >1.0·d–1 in August and September, then declined through the autumn of both years. Over the same period, spring protist grazing rates were low (~0.3 to 0.3·d–1), then became substantially negative (~1.1 to ~1.5·d–1) preceding the blooms in 2008 and 2009. During the bloom peaks, grazing rates quickly increased up to ~0.8·d–1 and remained high as the blooms decreased. Protist grazing directly on cyanobacteria was high in the spring (1.0·d–1), negative just before the bloom (~0.7·d–1 to ~1.0·d–1), and low in the autumn (0.3–0.7·d–1) of both years. Negative grazing on cyanobacteria immediately before the bloom may have been due to preferential grazing on other co-occurring prey, thus enabling the bloom to form, while higher grazing rates on cyanobacteria, especially on Aphanizomenon flos-aquae, in the fall likely contributed to the bloom’s decline. These findings show that microzooplankton can potentially influence cyanobacteria blooms directly and indirectly through grazing.

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LOW COST RETROFITS FOR STANDARD TIDE GATES AND RESTRICTED TIDAL MARSH CULVERTS TO FACILITATE ECOCLOGICAL RESTORATION

As the field of salt marsh restoration advances, the need for more innovative solutions to solve issues in tidally-restricted areas has emerged. Classic salt marsh restoration procedures have focused predominately on increasing hydraulic openings of tidal restrictions (i.e., culvert up-sizing) to allow increased passage of flow to upstream marsh areas. While effective, this technique is often cost prohibitive, poses challenging permitting issues, and is often met with resistance by public interest groups (i.e., upstream flooding concerns). As a result of research partially funded by the NOAA CICEET program, an alternative, real-time controlled, regulated tide-gate (RTG) has been developed as a viable option for salt marsh restoration. The RTG is a low cost and low maintenance air operated pinched valve that can be installed into an existing culvert without heavy equipment. The RTG operates on an independent power supply and has remote data access via the internet that enables real-time control and monitoring. This newly developed approach is the only technology currently available that actively controls upstream tidal levels using a goal-seeking algorithm to achieve stated inundation, low level elevation goals, and flood protection for salt marsh restoration without culvert enlargement. A generic restoration scenario would involve the system automatically monitoring water levels, closing the valve as the tide begins to ebb, and re-opening the valve as the tide begins to flood to allow for additional upstream inundation. The system can also automatically close the valve as the tide floods relative to the marsh to achieve low level goals. Cycling between inundation and low level goals, one can achieve a variety of complex, predictable, and precise, synthetic inundation patterns and frequencies. Future work will involve working with research partners to deploy and cycle the system for long periods of time to optimize operation and assess eco-system response.

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THE INFLUENCE OF DISSOLVED OXYGEN CONCENTRATION ON THE VERTICAL DISTRIBUTION OF LIFE STAGES OF THE COPEPOD, ACARTIA TONSA, IN CHESAPEAKE BAY

In order to assess the influence of bottom water hypoxia on the vertical distribution of copepods in Chesapeake Bay, we conducted diel studies at stations with more/less bottom hypoxia and during the beginning, peak and end of seasonal hypoxia. Whole water samples (10 liter Niskin) for copepods were collected from specific depths along with CTD, dissolved oxygen and fluorescence measurements. We enumerated copepod eggs and the developmental stages of the dominant copepods from the collected samples. Separate samples treated with the vital stain Neutral Red were used to assess the live/dead fraction of copepods from our collections. Using multivariate statistical techniques we will assess the influence of light, degree of stratification, temperature, salinity, fluorescence, oxygen and the predator field on the vertical distribution and abundance of the life stages of Acartia tonsa.

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POTOMAC RIVER RESPONSE TO BIOLOGICAL NUTRIENT REDUCTION AT BLUE PLAINS WASTEWATER TREATMENT PLANT

The Blue Plains wastewater treatment plant in Washington, D.C., is the largest advanced wastewater treatment facility in the world. The plant provides treatment services to over 1.7 million residents in the Washington, D.C., region. Wastewater treatment includes both sanitary waste, as well as storm-water flows from a combined sewer system for part of Washington, D.C. The plant is designed to treat an average of 370 millions gallons of...
The north IRL side remains dynamically different from ML and includes open boundaries near Ponce de Leon Inlet on the north side of the model domain. Flushing rate estimates within the Mosquito Lagoon (ML) on the north-central Florida coast vary with different flushing rates. The north IRL side remains dynamically different from ML and includes open boundaries near Ponce de Leon Inlet on the north side of the model domain. Flushing rate estimates within the Mosquito Lagoon (ML) on the north-central Florida coast vary with different flushing rates.

**EVALUATION OF THE POPULATION STRUCTURE OF THE WHITE SEABASS (ATRACTOCTON NELBIS) ALONG THE WESTERN COAST OF NORTH AMERICA BASED ON OTOLITH CARBONATE STABLE ISOPOTE ANALYSIS**

The white seabass, Atractoscion nobilis, is the largest Sciaenid found along the Pacific coast of North America. Its range extends from Magdalena Bay in the southern part of the Baja California peninsula, Mexico, to Alaska, USA. It is considered an important commercial and recreational fish species in both countries. Little is known about its ecology in Mexican waters, although most of the catch takes place in the late spring and summer. The main spawning areas are thought to be in the Southern California Bight (SCB) and Vizcaino Bay (VB). While seabass splay spawn during the summer, and some studies have suggested that there may be northward transport of larvae along the coast. Importantly, whether the populations that inhabit the coast of North America comprise one or more subpopulations is unknown. The isotopic composition (δ13C and δ18O) of otolith carbonate has been used as a natural tracer to distinguish between larval and juvenile fish that have grown under different environmental conditions. Oxygen isotopes are precipitated in equilibrium with the isotopic composition of the water, which is positively correlated with salinity. There is a negative relationship between temperature and δ18O values. In contrast, carbon isotopes in otolith carbonate are influenced through kinetic (metabolic) effects as well as the isotopic composition of the inorganic carbon pool. Given that there is a well-documented latitudinal gradient in temperature and other environmental conditions from the southern California Bight to the central waters off the Baja California Peninsula during the spawning season, we hypothesize that the stable isotope ratios of otolith carbonate may be used to discriminate among potential subpopulations of white seabass. We will test our hypothesis by analyzing the isotopic composition of otolith carbonate deposited during the larval and early juvenile stages and relating those values to local temperature and salinity regimes.

**SIMULATION OF FLUSHING RATE ESTIMATES IN THE MOSQUITO LAGOON, FL**

Flushing rate estimates within the Mosquito Lagoon (ML) on the north-central Florida coast were obtained using a three-dimensional numerical model (EFDC). The model domain includes open boundaries near Ponce de Leon Inlet on the north side of the model domain and in the northern compartment of the Indian River Lagoon (IRL), which is on the southwest side of the model domain. A single calibration station is available in the Haulover Canal (HOC), which connects the Mosquito Lagoon with the North IRL. A one year simulation is performed for four cases beginning on May 2, 1998. Flushing rates are reported as the day count when the percentage of mass concentration of numerical dye reaches 50% of initial concentration (or renewal time = R50). The goals of this study are to test the sensitivity of the various model scenarios to the bathymetry and select a baseline bathymetry for future model runs; ascertain an appropriate flushing rate for each of the dynamically different segments of the ML and to measure the effects of ground water on flushing rates. Results indicate that there are three main sections in the ML that have characteristics different flushing rates. The north IRL side remains dynamically different from ML and flushing rates for this area are in close agreement in all model cases. Flushing rate results (R50) at the ML side are higher (Case 3 = 92 days and Case 4 = 105 days) than those reported in previous studies (Christian et al., 2004) as R50 is reached at 74 days. Predicted flushing rates for the NIRL segment are in close agreement in all cases were R50 is reached at day 129 and compare well to previously reported results of 128 days for R50 (Christian et al., 2004).

**HABITAT CLASSIFICATION AND MAPPING OF GRAND BAY NERR, MISSISSIPPI: A CROSSWALK FROM THE NERRS CLASSIFICATION SCHEME TO CMECS**

A crosswalk from the National Estuarine Research Reserve System Habitat and Land Cover Classification Scheme (NERRSCS) to the Coastal and Marine Ecological Classification Standard (CMECS) will be performed on an existing habitat classification of the Grand Bay NERR, Mississippi. The NERRSCS classification of Grand Bay was derived from a combination of remote sensing data, including AISA hyperspectral digital imagery, elevation and water quality monitoring data. Habitat mapping and classification provides essential information for land use planning and ecosystem research, monitoring and management. The NERRS development was designed to support the NERRS System-wide Monitoring Program, which requires a standardized, high-resolution inventory and classification in order to perform change analyses. The NERRS scheme is based on the National Wetlands Classification Standard’s four-level hierarchy for the five wetland systems (Marine, Estuarine, Riverine, Lacustrine, and Palustrine) and adds three systems to accommodate non-wetland ecosystems (Uplands, Perennial Snow and Ice, and Cultural Land Cover). Some subsystems are re-arranged or terminology is added. The crosswalk demonstration undertaken here will provide a constructive evaluation of CMECS v 3.1 (August 2010) for application to the estuarine and nearshore marine habitats of the Grand Bay NERR. Strengths and weaknesses of CMECS for this setting will be discussed along with suggestions for improvement. In particular, the Water Column Component (WCC) in the estuarine environment has not yet been rigorously tested and will be of interest here. Since CMECS borrows from several existing schemes, this crosswalk may also serve as a template for the transition to CMECS once it has been confirmed as a national classification standard. The organization of the classification within a GIS geodatabase will also be discussed.

**ARE POPULATION-LEVEL EFFECTS OF HYPOXIA ON FISH TRULY SMALL OR LARGE BUT ELUSIVE?**

Hypoxia has clear mortality effects on sessile organisms but its population effects on mobile organisms in coastal environments are uncertain. The evidence for hypoxia having population level effects is laboratory experiments, many examples of localized effects in nature, a few population-level examples, fish kills, and, in some instances a well-known case at the Estuarine Reserve System’s Laboratory for Environmental and Ecological Studies. The National Estuarine Research Reserve System’s Laboratory for Environmental and Ecological Studies’ (NERR) data set was used to address the question of whether hypoxia has population level effects. Hypoxia causes large, but subtle changes in vital rates leading to population consequences. Population consequences include changes in population size, age structure, and gene flow. The effects of hypoxia on population size and age structure are likely undetectable using field sampling. Quantifying the effects of hypoxia on fish populations, whether large or small, is critical for effective management of coastal ecosystems and for cost-effective and efficient design of remediation actions. The potential for interaction effects, indirect effects, and subtle changes in vital rates leading to population consequences complicates field study and management, but does not excuse us from quantifying the population losses due to hypoxia. Improving our predictions of the effects of hypoxia on fish populations and communities has moved from a computational issue to a biological issue.

**MARINE BENTHIC QUALITY ASSESSMENT BY USING THE PEARSON-ROSENBERG MODEL**

The structure of marine benthic communities is known to change in a predictable matter in relation to increased organic enrichment and oxygen deficiency. When conditions change for the worse, some species will be eliminated and only the tolerant species that are able to adapt to the new conditions will survive. The Pearson-Rosenberg model, first presented in 1976 and developed in 1978, divided the benthic communities into four classifications according to gradients of organic enrichment: Grossly polluted, polluted, transitional and normal. The classification was made by professional judgement. There is an objective and quantitative method, the Benthic Quality Index (BQI). The index is a function of the sensitivity/tolerance value of each species, the dominance value and the species diversity. The species sensitivity/tolerance values have been assessed for about 400 Scandinavian benthic species. Sensitive species are not found in disturbed areas where tolerant species may be common. The BQI is used in some European countries for...
environmental quality assessment according to the European Union Water Framework Directive.

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THE ROLES OF AMERICAN ALLIGATORS IN A SUBTROPICAL ESTUARY

Understanding the movement and feeding patterns of estuarine top predators is crucial for understanding their ecological roles. However, changes in freshwater delivery and other anthropogenic changes to estuaries may have altered these roles. We used seasonal variation in environmental conditions (e.g., freshwater inputs) to elucidate their impacts on foraging ecology and movements of American alligators (Alligator mississippiensis) in the oligotrophic coastal Everglades and to gain insights into possible historical changes in their ecological role. We used a combination of passive acoustic telemetry and GPS telemetry to assess movements and stomach contents and stable isotope analysis to determine foraging patterns. We found that individual alligators were capable of long distance movements over short time periods and adopted one of three distinct movement tactics that were linked to variation in diet. The adoption of a particular tactic was associated with tradeoffs between access to food resources and likely salt stress. Also, one of the movement/feeding tactics indicated that alligators may act as vectors of nutrient transport between marine and brackish waters. The use of this tactic, however, varied with salinity of the estuary, suggesting that anthropogenic changes to freshwater delivery likely have modified, and will continue to modify, their ecological role. We further found that alligators consumed prey at lower trophic levels than we hypothesized, and that this may have been caused by past human impacts. Ultimately, our results show that because of their ability to move long distances in short amounts of time, alligators could possibly be important in nutrient transport and as simultaneous stabilizing top-down forces in disparate habitats. These roles will most likely change as habitat restoration (in the form of increased delivery of freshwater to the estuary) and sea level rise continue, but the degree of change will be difficult to predict.

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EFFECTS OF OXIDATIVE STRESS AND ELEVATED TEMPERATURE ON CORAL LARVAE HEALTH AND POST-SETTLEMENT SURVIVAL

The coral larval planktonic life history stage represents a critical period that has direct implications on subsequent recruitment processes. As coral reefs across the Caribbean decline in cover recruitment has been identified as a key process necessary for the recovery of coral reef communities. While elevated temperature and ensuing oxidative stress effects have been reported to affect settlement of coral larvae, there have been limited studies describing the physiological sublethal stress responses of coral larvae that have been directly exposed to oxidative stress. Furthermore, evaluation of the longer term post-settlement survivorship has not been thoroughly investigated. Föttesi astreides larvae that were exposed to an elevated temperature (+3.5 °C for 24 h) demonstrated a significant reduction in photosynthetic efficiency and a concomitant increase in respiration. The addition of micromolar levels of hydrogen peroxide had no impact on either endpoint. Catalase activity and lipid peroxidation both increased as a function of elevated temperature or exposure to H2O2. Larval settlement was reduced by elevated temperature but not by H2O2 exposure. After 24 days post-settlement survival was reduced in the majority of treatments. These results suggest that while short term exposure to selected stressors may have a negligible impact on coral stress physiology and settlement, longer term monitoring of recruits is warranted to accurately monitor survivorship.

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LAGRANGIAN OBSERVATIONS OVER A REGION INFLUENCED BY THE MOBILE BAY OUTFLOU PLUME

With the purpose of determining the flow field in the outflow region of the Mobile Bay plume, a series of ten surface drifters were deployed along a 25-km long transect in August 2011. This region is located around 30 degrees of latitude and is characterized by 24 h inertial periods that are very close to the dominant diurnal tidal periods. The drifters were equipped with global positioning system units that transmitted their coordinates every ~30 minutes. Two different flow regimes were identified with the drifter trajectories. Within an inner shelf band of ~15 km from the shore, the drifters oscillated in inertial circles with net onshore displacement near 0.05 m/s. The inertial circle diameters were between 5 and 10 km and speeds that exceeded 0.6 m/s on the onshore part of the transect, but that remained below 0.5 m/s on the offshore part. The dynamics within this inner shelf band is assumed to be nearly geostrophic with weak frictional influence. Offshore of the inner shelf band, drifters also depicted inertial circles that were greatly distorted by an eastward drift that was in the opposite direction to that expected from Coriolis acceleration. The reason for this eastward displacement is under investigation but it could be linked to wind forcing, through Ekman dynamics, or to a gulf-wide circulation driven by the Florida Strait. Rozas, L. P., NOAA Fisheries Service, Lafayette, LA, USA, lawrence.rozas@noaa.gov; Minello, T. J., NOAA Fisheries Service, Galveston, TX, tom.minello@noaa.gov; Dantin, D. D., U.S. Environmental Protection Agency, Gulf Breeze, FL, USA, Dantin.Dantin@epa.gov

USE OF SLALLOW LAGOON HABITATS BY NEKTON OF THE NORTHEASTERN GULF OF MEXICO

We compared density and biomass of fishes and crustaceans among seven habitat types located within a lagoonal system of the northeastern Gulf of Mexico (GOM). The habitat types incorporated into our sampling design were defined by combinations of structure (cover type) and location (distance from shore) as: Spartina edge (1m from shore), Spartina 3 m from shore, Juncus edge (<1m from shore), seagrass located 3.5, and 20 m from shore, and shallow nonvegetated bottom (SNB) at various distances from shore. Although most environmental variables differed little between seagrass and Spartina edge sites, the density and biomass (measured using a 1-m² drop sampler) of most abundant taxa including pink shrimp Farfantepeneaus duorarum, doggerel grass shrimp Palaeonetes pugio (spring), tatwater killifish Lucania parva (spring), and bigclaw snapping shrimp Alpheus heterochaelis (fall) were detected in seagrass and Spartina marsh, the abundance and biomass of most species did not differ with distance from shore. Few differences in habitat use were detected between Juncus edge and Spartina edge sites, but in fall, the abundance and biomass of pinfish Lagodon rhomboides were significantly higher at Juncus edge sites. Our study revealed a pattern of nekton distribution in this lagoonal system that is clearly different from marsh dominated systems of the north-central and northwestern GOM where nekton are concentrated within emergent vegetation at the marsh shoreline. Fishes and crustaceans of this lagoonal system were either most abundant in seagrass or more evenly distributed between the marsh edge and adjacent seagrass beds.

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TRADE-OFFS AT THE EDGE OF THE EVERGLADES: MANAGING RESTORATION, RISKS AND EXPECTATIONS

Restoration of the greater Everglades ecosystem, including Florida Bay, is being planned and implemented via hydrologic modifications. However, these modifications are also associated with a complex set of trade-offs regarding nutrient enrichment, disturbance of communities and species adapted to the current hydrologic conditions, and human communities that require the maintenance of flood control and water supply. The trade-off between water quantity for restoration and water quality within the Everglades, especially related to phosphorus loading, is a well documented major hurdle for ecosystem restoration. In the southeastern Everglades, a major project of the overall restoration plan, the C-111 Spreader Canal Project (C-111SC), is underway. With low P in this region’s canals, extensive wetland water quality trade-offs were not expected here, but cattail expansion associated with P enrichment in ENP (Ward et al., 2016) was detected before the project’s implementation. The source of this P is uncertain, but may have entered ENP from adjacent agricultural lands via the direct pumping of canal water into ENP in the 1990s. The C-111SC Project is designed to restore more natural hydrotopotypes in ENP by raising water levels in boundary wetland detention areas to minimize seepage out of ENP. However, with higher water levels, subsuppositions of the endangered Cape Sable Seaside Sparrow, which are adapted to relatively dry conditions, may encounter increased risk. Residential communities and farms, which have expanded to the ENP boundary, expect current conditions to be maintained. In order to manage these risks and expectations, the C-111SC Project will modify boundary water levels in small increments over five years and sustain an extensive monitoring network to assess hydrological and ecological responses.

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DETECTION OF PH SHIFTS IN THE SOUTH SLOUGH ESTUARY, OREGON: EXPLORATION OF RELATIONSHIPS BETWEEN CHANGING CARBONATE MINEROSITY, EUTROPHICATION, AND NET ESTUARY ECO SYSTEM METABOLISM

Time-series analysis reveals a long-term directional shift in pH measurements within the tidal waters of the South Slough estuary (Charleston, Oregon, USA). Measurements of pH
levels were recorded every 30 minutes by a series of YSI-6600 dataloggers operated by the South Slough National Estuarine Research Reserve System-wide Monitoring Program. The dataloggers documented a directional shift toward increased median pH values over the period of 2002-2010, and the shift in pH values was consistent at four stations located along the estuarine gradient. Median pH values shifted from 7.9 in 2002 to 8.1 in 2010 at the marine-dominated station, from 7.4 to 8.0 at the mesohaline station, and from 7.2 to 7.4 at the riverine station. Substantial variability in estuarine pH values occurred in pH fluctuations over 0.4 pH units in a single day. We did not observe any consistent shift in pH values between the wet (winter) and dry (summer) seasons. It is possible that the shift toward increased pH values provides an early indicator of eutrophication within the shallow tidal slough. In addition, it is also possible that changes in median pH values may occur in response to microbial activity in the sediments (Zostera marina), coupled with increases in phytoplankton and/or macrobenthic algal communities. Long-term monitoring of an adjacent eelgrass bed reveals a slight increase in density and spatial cover, and we also observed an increase in water-column Chi-a concentrations over the period of 2004-2010. These observations indicate that the net ecosystem metabolism of the South Slough estuary is produced by radiation rather than by respiration. The trend toward increased alkalinity is problematic, however, because pH levels are influenced by many factors including ocean acidification, carbon cycling, freshwater inputs, tides, photosynthesis/respiration, dissolved oxygen concentrations, salinity, nutrient availability, and denitrification.

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AN INTEGRATIVE APPROACH TO ECOSYSTEM GOODS AND SERVICES - PUTTING THE PIECES TOGETHER FOR THE TAMPA BAY REGION

Ecosystem goods and services production, delivery, and use by humans involve multiple systems working together at various different spatial and temporal scales. Assessments of ecosystem goods and services and their benefits to current and/or future human populations in any given region requires an understanding of complex and interwoven biological and physical pathways. These assessments, by their very nature, require a multidisciplinary team to complete. Here we present the approach taken by such a team developing models and predicting the production of ecosystem goods and services in the Tampa Bay Region and present comparisons between wetland nitrogen processing and the land use in areas draining to them. Ongoing field research including water level, nutrient, and denitrification potential measurements along a gradient of developmental pressure and among different wetland types is helping to inform dynamic simulation models of the functionality of these wetlands. We present several of these model’s results. Functional assessments and model results are being linked to social economic values for the derived final ecosystem goods and services that are generated and weighted through connectivity networks coupling ecosystem production to human demand or use. We present here an inter-disciplinary approach is producing a more holistic view of coupled human ecological systems.

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REMEMBERING OUR WATER HERITAGE

People alive today can remember when Florida was a place of great abundance - the bays were filled with fish and the skies were dark with birds. Scientists are sometimes called upon to create a vision for the future and they naturally look for historic data but find it doesn’t exist. Stories from the people involved with the water - fishermen, sailors, surfers, and boat builders share a common theme – that there has been tremendous change during their lives. Capturing the water stories of a community helps create a vision for the future based on a common understanding of the past. Sarasota County Water Resources developed a partnership with New College of Florida, the University of South Florida Water Atlas, and the County History Center to capture these stories in the voices and photos of the people who lived it. Anthropology students interview old time residents and/or their photographs to create fascinating, narrated slide shows that are posted online. Slides shows are premiered at an event that draws together a wide range of young and old and celebrates the community. The students earn a valuable internship and the County learns the stories that only a few people can still remember. Along the way unexpected lessons are learned. Other communities can use this inexpensive approach to enhance community involvement and create a vision for the future by looking through a lens to the past.

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A NINE-YEAR RECORD OF ELEVATION DEFICITS WITH RESPECT TO RELATIVE SEA-LEVEL RISE IN A PACIFIC NORTHWEST ESTUARY

Beginning in 2002, a network of 24 stable benchmark surface elevation tables (SBETs) were installed in the intertidal mudflats and eelgrass beds (Zostera marina) of Padilla Bay, a National Estuarine Research Reserve located in Washington State, USA. Padilla Bay, an estuary of the Skagit River system, is home to one of the largest eelgrass meadows in the Pacific Northwest, however, dams, diversions, and levees along the river have reduced sediment loads to the point that the river is no longer a major source of sediment to Padilla Bay. The objective of our study is to measure long-term elevation change and to determine if intertidal elevation is keeping pace with current and predicted rates of regional relative sea level rise. After nine years, nine SBET stations showed a statistically significant decrease in elevation, nine stations revealed no significant change in elevation over the period of record, and only one SBET station showed a significant increase in elevation (five stations were dropped from the analysis because of problems related to SET-induced scour). Rates of surface elevation change throughout Padilla Bay ranged from -0.80 cm/yr to 0.22 cm/yr, with a mean rate of surface elevation change of -0.22 ± 0.27 cm/yr (± standard deviation). All stations exhibited an elevation deficit with respect to relative sea level rise (elevation deficit = elevation change – ESLR + geologic uplift). Elevation deficits ranged between -0.04 cm/yr to 0.02 cm/yr, with a bay-wide mean elevation deficit of -0.46 ± 0.27 cm/yr (± standard deviation). We also used the data generated from the SET sites to initialize and calibrate a two dimensional ecogeomorphic model for Padilla Bay. The model revealed that, given predicted rates of sea level rise over the next one hundred years, eelgrass distribution within the bay would change but bay-wide net eelgrass productivity would not decrease.

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LONG-TERM REDUCTIONS IN ANTHROPOGENIC NUTRIENTS LINK TO IMPROVEMENTS IN CHESAPEAKE BAY HABITAT

Submerged aquatic vegetation (SAV) is a critical habitat for invertebrates, fish and waterfowl, but SAV ecosystems are declining worldwide. Habitat restoration can improve biodiversity and ecosystem function, but recovery to pre-disturbance states is rare. The ability of environmental policy to address restoration is limited, in part, by uncertainty in the relationships between costly restoration and benefits. Here we present results from an 18-year field investigation (1990-2007) of SAV community dynamics and water quality in the Potomac River, a major tributary of the Chesapeake Bay. Light attenuation limits SAV abundance throughout the Chesapeake Bay and other populated estuaries. River and anthropogenic discharges lower water clarity by introducing nutrients that stimulate phytoplankton and epiphyte growth, as well as suspended sediments. Efforts to restore Chesapeake Bay are often viewed as failing. Overall nutrient reduction and SAV restoration goals have not been met. In the Potomac River, however, reduced in situ nutrients, wastewater treatment effluent nutrient dilution, and total suspended solids were significantly correlated to increased SAV abundance and diversity. Species composition and relative abundance also correlated with nutrient and water quality conditions, indicating declining fitness of exotic species relative to native species during restoration. Our results suggest that environmental policies that reduce anthropogenic nutrient inputs do result in improved habitat quality, with increased diversity and native species abundances.

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DEVELOPMENT OF IMPROVED SAV DETECTION AND SPECIES DISCRIMINATION CAPABILITY WITH FUSED AIRBORNE BATHYMETRIC LIDAR AND HYPERSONSPECTRAL DATA

Detection of submerged aquatic vegetation (SAV) from an airborne or space borne remote sensing platform is challenging under most conditions. Further, species discrimination of the detected SAV is even more difficult task. An airborne lidar and hyperspectral sensor system, such as the Compact Hydrographic Airborne Rapid Total Survey (CHARTS), combined with mathematical inversion tools to remove the confounding effects of the atmosphere and water column, presents a spectral and spatial data set of great interest for electro-optical remote sensing. In addition to data collected with CHARTS, a carefully controlled ground truth data set was simultaneously collected at two Massachusetts harbors containing ecologically valuable eelgrass (Zostera marina) and multiple species of marine macroalgae. Various levels of image data processing were performed, ranging from generation and
DETECTING PATTERNS OF WATER QUALITY AT MULTIPLE SCALES: A MATRYOSHKA-BASED MONITORING APPROACH FOR PUGET SOUND

Marine waters of Puget Sound are an important natural resource for people living in Washington State. Toxins, bacteria, eutrophication, harmful algal blooms and an increasing population are all factors that affect water quality. The effectiveness of conventional monitoring approaches is often limited due to the ephemeral nature, immense scale, and complexity of many estuarine processes. A Matryoshka-based approach to marine monitoring is meant to evoke the image of Russian nesting dolls. The approach seeks to develop products that nest within one another to support analyses across a range of time and space scales. In May 2010 the Washington State Department of Ecology (WaECY) deployed a Turner Designs C3 fluorometer in a seacrest system onboard the Victoria Clipper IV; a passenger ferry that travels daily between Seattle, Washington and Victoria, British Columbia. The C3 measures chlorophyll fluorescence, CDOM fluorescence, turbidity, and temperature. Ferry data are used in combination with data from the European Space Agency’s MERIS ocean color satellite which provides estimates of suspended sediments, chlorophyll concentration, and other indices of algal biomass. WaECY has developed methods to use data from this unique ferry-based monitoring program to validate satellite products and to complement its other marine monitoring activities (ftp://www.ecy.wa.gov/dep/Flight_Blog/latest_pictures/April_2011_Eyes_Over_Puget_Sound.pdf). By combining disparate datasets and leveraging existing satellite technology WaECY is developing a high quality time series of remotely-sensed data products, tuned to conditions in Puget Sound. These products provide a cost-effective way to extend WaECY’s monitoring capabilities and improve our ability to characterize and predict marine surface water quality in different areas of Puget Sound.

MIGRATION OF INTERTIDAL OYSTER REEFS ALONG BOATING CHANNELS IN THE NORTHERN INDIAN RIVER LAGOON SYSTEM

Intertidal reefs of the keystone ecosystem engineering eastern oyster Crassostrea virginica are declining due to boat wakes along major boating channels in the shallow, northern portion of the Indian River Lagoon system (Mosquito Lagoon). Seaward edges of oyster reefs along major recreational boating pathways are characterized by high piles of dead, bleached, and disarticulated oyster shells forming reef crests (dead margins) that typically extend above mean high water. These dead margins separate wave-washed fore-reefs adjacent to the channel from landward reefs toward the shoreline. To determine the history and stability of these dead margins, the positions of dead margins and live reefs were mapped on adjacent to the channel from live reefs toward the shoreline. To determine the history and stability of these dead margins, the positions of dead margins and live reefs were mapped on

South Florida. In August 2009 approximately 20 acres of reef habitat were constructed in the St. Lucie River Estuary (SLE) using harvested oyster seed from a nearby hatchery and about 220 reef flats, each approximately 232 m2 in size. Colonization of sessile and motile invertebrate species was recorded on the created reefs 3 weeks after installation; however, oyster spat settlement remained sparse until month2 (October 2009). Species richness increased from 5 to 18 species and oysters had grown as large as 60 mm (shell height) within 5 months. The reduced spat settlement resulting from the 2010 Lake Okeechobee releases did not have a significant effect on oyster survival. These freshwater releases may be linked to habitat degradation in the SLE caused by increased sedimentsation rates. We used a 2 x 2 factorial experimental design to elucidate the separate and combined effects of topographic relief and architectural complexity of the fossil shell matrix on the development of the invertebrate community. Topographic relief had a significant effect on sessile species abundance with Balanus and Mogula representing the most dominant taxa. There was not an effect of complexity or the interaction between relief and complexity in terms of overall abundance; however, complexity did have a significant effect on species similarity, again driven by Balanus and Mogula species.

MACROALGAL DYNAMICS AND NUTRIENT CONTENT REVEAL TROPHIC STATUS IN BISCAYNE BAY

The Coastal ecosystems of South Florida are affected by their hydrologic connectivity with the Florida Everglades; the water flow from the Everglades has been dramatically modified as a response to the rapid coastal development of the region. The Comprehensive Everglades restoration plan (CERP) is a program whose main goal is to recapture and redistribute fresh water and restore the natural hydroperiod by increasing freshwater flows into coastal lagoons. This might cause unknown changes in salinity regimes and nutrient availability affecting the submerged aquatic vegetation (SAV). The aim of this study was to identify differential effects of salinity and nutrients availability between two contrasting sites in Biscayne Bay: Black Point (BP) and Deering Bay (DB). BP is directly affected by a canal while Deering Bay is relatively isolated from any direct freshwater discharge. The outcome of this study is to provide potential scenarios of future expected changes in water quality using macroalgae spatio-temporal dynamics, and tissue nutrient content as bioindicators for the Bay. Results reveal that salinity is lower and more variable in BP than in DB. Salinity stability resulted in higher macroalgal diversity in DB than BP. Estuarine species dominate BP while marine species dominate DB. The dominant seagrass in DB is Thalassia testudinum, while BP has Thalassia testudinum on North and Halodule wrightii in the South section of its dividing jetty. Macroalgae tissue nutrient composition is different among sites, but in general %N and N:P ratios reveal high levels of N and P limitation. Nutrient loading by a nearby landfill and managed freshwater inputs from the Black Point canal might be the sources of high levels of nutrients in BP. Although DB does not have the same amount of stresses as BP, it is still impacted by some anthropogenic influences such as nutrient loads. This study provides a powerful SAV bioindicator of different salinity-nutrient conditions.

TRACING CARBON CYCLE DYNAMICS IN SHALLOW COASTAL SEDIMENTS USING AN IN SITU LABELING EXPERIMENT

Benthic microalgae (BMA) living at the sediment-water interface are influenced by a variety of physical processes such as resuspension, salination and mixing, which subsequently affect the cycling of biochemically active elements. Primary production in shallow coastal sediments can be dominated by benthic production and BMA play an important role in this carbon cycle. The major organic product is the carbohydrate, an essential class of biological compounds, and much of it is exuded from the benthic microalgae as extracellular polymeric substances (EPS). This study employed the use of isotopic tracers (δ13C and δ15N) and a novel experimental tool called the perfusionator to label the sediment pore waters in situ. To understand the role of the physical regime on EPS production, rigid plastic covers were deployed over a subset of the physical regime on EPS production. Sediment properties, density-based extractions using Ludox to isolate the benthic microalgae and carbohydrate composition and content were analyzed to trace the carbon pathways in the system, while glass beads were used to trace the physical mixing of the sediments. Average carbon enrichment of the benthic microalgae ranged from baseline of ~3.6 ± 0.52 mg per ml to 57.9 ± 91.43 mg per ml at day 21 (approximate peak of labeling). Hot biocarbonate extracted
EFS had average carbon enrichments of 2.7 ± 18.28 per mil on day 4 and 16.1 ± 15.77 per mil on day 26. On average, the carbon content and enrichment of covered perfusorans was higher than in open perfusorans. At the end of the experiment, an average of 52% of the glass beads were mixed below 5cm depth in open perfusorans and on average 27% of the glass beads were mixed below 5cm depth in covered perfusorans. These data indicate that the covers reduced the amount of physical mixing occurring within the sediments, allowing for greater incorporation of the isotopic label into the sediments and associated benthic microalgae.

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TIDAL AND NON-TIDAL OSCILLATIONS IN A SHALLOW COASTAL LAGOON IN THE YUCATAN PENINSULA

The Carbonera Lagoon, located in the northwest coast of the Yucatan Peninsula in Mexico, is a small (15 km2) and shallow (0.3-2 m deep) coastal lagoon connected with the ocean via a single inlet. Inlets to lagoons provide access for diffuse sources as well as point sources from the underlying confined aquifers. The energy regime is low, with a tidal range of relatively small (0.5-1 m), and a low energy wave climate (Hs=0.5-1.5 m). Preliminary examinations of CTD (conductivity, temperature and depth) records inside the lagoon (5 sites with 30 day records, and 9 stations with 24 hour records during both spring and neap tides), as well as water flow through the inlet show that only a fraction of the WSE oscillations, suggesting that the wind regime and the freshwater input play an important role. This phenomenon, which is fundamental to understanding the ecosystem behavior, is addressed through data analysis and hydrodynamic modeling with different forcing scenarios.

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ADH HYDRODYNAMIC MODELING OF THE SACRAMENTO-SAN JOAQUIN DELTA

The USACE’s new multi-dimensional hydrodynamic model, ADH (ADaptive Hydraulic Model) was applied to the Sacramento – San Joaquin Delta to evaluate the impacts of a levee breach on a large island within the system. The ADH model is a unique conservative, implicit, finite element hydrodynamic modeling software developed by the USACE Coastal and Hydraulics Lab software that allows the model to automatically refine or coarsen the model grid during the simulation providing more accurate and more stable solutions. The Delta is the largest estuary in the Western United States and a vital economic and ecological resource and provides habitat for many threatened and endangered species. Further development, land subsidence, invasive species, seismic risk, and changing weather and climate will challenge the Delta’s infrastructure and provide further stress on the ecosystem in the future. A two-dimensional hydrodynamic model of the Delta was developed using the ADHaptive Hydraulics Model (ADH) to examine the local hydrodynamic effects and flooding patterns due to a simulated levee breach at Sherman Island. The model was validated to observed stage, discharge, and salinity data from 2004. As a result of the breach, the model results indicated an increase in net flow toward the breach resulting in increased salinity in the system which would have adverse impacts from both ecological and water supply perspectives. The combination of ADH’s ability to adapt, refining elements near the breach, and handle the complicated hydraulics at the breach site make it an good tool for complex hydrodynamic applications.

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CHALLENGES OF MODELING SHALLOW, NEARSHORE WATERS

One of the most challenging problems facing estuarine water quality modelers is the treatment of shallow nearshore water zones within the context of large, system-wide models. These nearshore zones take several different forms, including beaches backed by different shorelines (eroding, armored, developed, agricultural, etc.), underwater grass beds, marshes, and small embayments with or without freshwater inputs. They are directly impacted by both land and water, with widely varying physical, geological, biogeochemical, and ecological characteristics. This variability may occur across large scales or within the scale of a single model grid cell. While the complexity of these environments can be daunting, they must be considered for at least some system-wide water quality goals. For example, in Chesapeake Bay the shallow nearshore is the primary habitat for underwater grasses, one of the key metrics of Bay restoration. This talk will outline a framework for practical modeling of shallow nearshore environments, with specific reference to Chesapeake Bay. The framework includes identification of representative groups of nearshore habitat characteristics and development of sub-grid process parameterizations that represent a balance between realism and practicality for inclusion in system-wide water quality models. A preliminary underwater grass habitat model will be presented as an example. In concept, connecting appropriate nearshore habitat models in series around the perimeter of a water body may allow for realistic buffering of land-water exchanges without excessive computational overhead.

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GULF OF MEXICO TIDAL CREEKS: SENTINEL HABITATS FOR ASSESSING THE IMPACT OF COASTAL DEVELOPMENT ON ECOSYSTEM HEALTH

Tidal creeks have been used as a sentinel habitat to assess the impacts of coastal development on estuarine areas in the southeastern U.S. A conceptual model for tidal creeks in the southeastern U.S. identifies that human alterations of upland in a watershed such as increased impervious cover (stressors) will lead to changes in the physical and chemical environment (such as microbial and nutrient pollution (exposures)) of a receiving water body which then lead to changes in the living resources (response). The overall objective of this study is to evaluate the applicability of the current tidal creek classification framework and conceptual model linking tidal creek ecological condition to potential impacts of development and urban growth on ecosystem value and function in the Gulf of Mexico U.S. through collaborations with Gulf of Mexico National Estuarine Research Reserves (NERR) sites. The conceptual model was validated for the Gulf of Mexico U.S. tidal creeks. The tidal creek classification system developed for the southeastern U.S. can be applied to the Gulf of Mexico tidal creeks; however, some differences were found that warrant further examination. In particular, pollutants appeared to translate further downstream in the Gulf of Mexico U.S. compared to the southeastern U.S. These differences are likely the result of the geographic differences between the two regions. Tidal creeks were found to serve as sentinel habitats to provide an early warning of the ensuing harm to the larger ecosystem in both the southeastern and Gulf of Mexico U.S. tidal creeks.

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APPLICATION OF TIDAL CREEK RESEARCH IN MANAGEMENT DECISIONS

Headwater tidal creeks are dynamic and complex ecosystems located at the interface between the landscape and estuaries and are the primary aquatic link between coastal development and estuaries. Increases in stormwater runoff from coastal development impair the integrity and human uses of tidal creek ecosystems. This impairment occurs decades in advance of similar impairment in other habitats making tidal creeks sentinel of ecosystem and public health threats. The amount of impervious surfaces in tidal creek watersheds is a good indicator of the amount and flashiness of stormwater runoff. Adverse changes in the physical and chemical environment generally occur when watershed imperviousness exceeds 10-20%. Ecological processes are impaired when imperviousness exceeds 20-30%

Estimates of impervious cover levels defining where human uses and public health are impaired are currently being determined, but it generally appears that shellfish beds closures and the flooding vulnerability of headwater regions become a concern when imperviousness exceeds 20-30%

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OCEAN ACIDIFICATION, CORAL REEFS AND POROWATER EXCHANGE IN PERMEABLE SANDS

Permeable CaCO3 sands cover much of the world’s continental shelves, coral reef lagoons, and tropical beaches. Dissolution of CaCO3 releases alkalinity which can partially buffer coastal waters against ocean acidification. Current estimates of CaCO3 sediment dissolution in the global coastal ocean suggest a relatively minor influence on the invasion of anthropogenic CO2. However, these estimates are based exclusively on experiments
performed under diffusive conditions. Groundwater and porewater advective transport in permeable sands efficiently transport reactants deep into the sediment, enhancing the effective area where water exchange takes place and magnifying benthic biogeochemical processes such as respiration. We have performed field observations at Heron Island (Great Barrier Reef) demonstrating the role of advection in permutable sands in proton (H\textsuperscript{+}), O\textsubscript{2}, CO\textsubscript{2}, and alkalinity cycling in a coral reef lagoon. The die range in the lagoon water chemistry (dissolved oxygen: 28-463 µM; pH: 7.69-8.44; aragonite saturation state: 1.7-6.8) appear to be the broadest, and the night-time values are among the lowest ever reported for healthy coral reefs. Shallow lagoon porewater and island groundwater have high variable alkalinity concentrations ranging from less than half to 3-fold higher than the adjacent lagoon. We estimated that the net contribution of permeable sands to the whole system H\textsuperscript{+} fluxes was only 9% during the day, but approached 100% at night when small scale (i.e., flow and topography-induced pressure gradients) and large scale (i.e., tidal pumping as traced by radon) seawater recirculation processes were synergistic. Reef lagoon sands were a net sink for H\textsuperscript{+} and CO\textsubscript{2} and the sink strength was a function of porewater flushing rate. Our observations suggest that CaCO\textsubscript{3} cycling in advection-dominated carbonate sands may provide a currently unknown but potentially important feedback to ocean acidification.

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SYNTHESIS OF SOIL ORGANIC MATTER AND NUTRIENT ACCUMULATION IN THE EVERGLADES SOUTHERN COASTAL ECOTONE: IMPLICATIONS FOR HYDROLOGIC RESTORATION

Integral to the Comprehensive Everglades Restoration Plan, the C-111 Spread Canal Project (C111SC) will implement water management structural and operational changes to restore hydrology and ecosystem function in the southeast coastal ecotone region in Everglades National Park (ENP), at the confluence of marsh, mangrove and estuarine habitats. Freshwater ecosystem processes (modulated by water management) control the quantity and quality of organic matter (OM) and nutrient inputs to mangroves, which then exchange OM and nutrients with the estuary. Increased freshwater delivery is expected to maintain or enhance oligotrophy; and soil nutrient retention and accumulation is a key function. Successful restoration requires information on (1) historic soil OM and nutrient accumulation rates; (2) mechanisms influencing these accumulation rates; and (3) optimal water operations for achieving performance targets. Using available data from radiometrically dated soil cores and Sediment Erosion Tables (SETs), we review soil vertical accretion/evolution change and soil OM and nutrient accumulation rates among the major Everglades freshwater and coastal habitats. We then focus on a 10-km freshwater-to-marine transect in Taylor Slough (ENP), where restoration effects of the C111SC project are anticipated. Generally, radiometric-based accretion and OM accumulation tended to decrease toward the coast. Transect-wide, soil P accumulation was typical of the oligotrophic Everglades (15-70 mgP m\textsuperscript{-2} yr\textsuperscript{-1}). Spatial patterns of accumulation appeared to change in the late 20th Century, with highest P and N accumulation shifting southward, contrasting with accretion and OM accumulation patterns. This observed variation is examined in terms of likely influences of water management, natural (climatic/hydrologic) variability, disturbances, and sea-level rise. Implications for establishing expectations, performance targets and optimal operations for the C111SC project are discussed.

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ECOSYSTEM-BASED APPROACH: THE FORWARD PROJECT - FRAMEWORK FOR RIA FORMOSA WATER QUALITY, AQUACULTURE, AND RESOURCE DEVELOPMENT

One of the current challenges in coastal ecosystem management (e.g. in the EU through the Marine Strategy Framework Directive) is to protect, optimize, and manage in a sustainable manner the various activities and resources of coastal areas such as the Ria Formosa, in southern Portugal. This coastal lagoon is a complex barrier island system, which is both a marine protected area and has the highest farmed bivalve production in Portugal, and therefore of high natural and socio-economic value. The FORWARD project aims to assess the ecological integrity of the lagoon, through a combination of field and laboratory studies, and simulation models, in order to stimulate the development of innovative and technologically advanced activities together with best environmental practices. The project applies an ecosystem-based approach to aquaculture production in the Ria Formosa, with the integration of ecological and screening models, together with social and economic aspects, in order to provide support for optimal management of ecosystem goods and services. An Ecosystem Approach to Aquaculture (EAA) requires ecological integrity, social equity, and multi-sectorial planning. Clearly, only a part of the EAA may be addressed by simulation models. We present results for that component, combining watershed, hydrodynamic, and ecological models at various scales, but we additionally discuss other components that, although not amenable to modelling, are equally important for sustainable development. This emphasizes the fact that just because we have better quantitative tools to address 50% of a problem, the other half cannot be neglected.

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MINIMAL LOCALIZED EFFECTS OF STORMWATER RUNOFF ON OXYGEN DYNAMICS ON SALT MARSH PLATFORMS

In order to evaluate the potential effects of urban stormwater runoff on an estuarine salt marsh, oxygen concentrations were monitored continuously at two intertidal marsh sites near Savannah, GA. The Vernon River site receives significant runoff from the urbanized Savannah watershed via a network of stormwater drainage canals. The Skidaway River site is bordered by woodlands and receives no significant upland runoff. Overall, local effects of urban runoff on oxygen dynamics of the flooded salt marsh on the Vernon River were almost undetectable relative to the control site. Oxygen concentrations and oxygen consumption rates were similar at both sites regardless of stormwater input. Locally intense stormwater inputs have a relatively small volume and are rapidly exchanged with the much larger regional water reservoir. The large mixing energy of the tide mutes the local inputs and disperses their effects over a broad area, causing the absence of any detectable effect near the canal outfalls. The results of our study illustrate the problem of selecting an appropriate scale for identifying and monitoring environmental impacts in a dynamic intertidal environment.
In order to implement adaptive management in the Comprehensive Everglades Restoration Plan (CERP) and to measure progress towards ecosystem restoration, a significant amount of sampling is performed - from water quality and quantity sampling to that which is more biological in nature. Although there is a database for the water quality and quantity measurements, one did not exist for biological/ecological data. Thus in order to determine how the water quality and/or quantity and the biological data were related or how the biological data was related to each other, several spreadsheets worth of data had to be located and either manipulated (re-arranged) by hand or a specific script had to be written to formulate each combination of data. This proved to be very time consuming and concerns were raised as to whether unanticipated correlations were being missed or if data itself was being missed. A SQL-based database was created for the storage and retrieval of biological and ecological data collected as support of CERP. The CERP Integrated Database was designed based on input from the scientists who analyze the data as well as those who collect it. The input process allows for quality assurance by contract managers before final acceptance into the database. Data from the following sampling activities can be stored: Algae; Bacteria; Bird; Climate Conditions; Fish; Ground Water; Herpetofauna; Invertebrates; Location (physical); Mammal; Nekton; Periphyton; Plant; SA V; Soil/Chemistry; Surface Water. This database contains a spatial component - connection to a GIS/SDE oracle based geospatial database. This feature allows the biological and ecological data collected for CERP to be easily located through a point and click web interface. Data can be queried and extracted either spatially or by station and allows for simple combination with other sampling data. Since the database is based on industry standards, it can also be connected to other biological databases.

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RELATIONSHIPS BETWEEN INSTREAM NUTRIENT LOADS AND WATERSHED NUTRIENT INPUTS

An understanding of the sources of nitrogen (N) and phosphorus (P) to waterways is essential for managing and reducing coastal eutrophication. To better understand the relationships between nutrient inputs to watersheds and in-stream water quality, we have combined calculations of the sources of N and P to the subwatersheds of the Altamaha River, Georgia watershed with monthly measurements of N, P, and a number of other parameters at the outlets of these subwatersheds. Average monthly loads of both N and P expressed as kg km-2 yr-1 were best related to those components of the N and P budgets which reflect livestock population in the watershed (e.g., livestock consumption and excretion). These relationships held true for all forms of N measured (NO2, NO3, NH4, DON, and PON). However, average monthly concentrations of the different species of nitrogen were not uniformly related to livestock abundance. Human consumption (among others) was related to concentrations of N2O, NO3, and TN, whereas atmospheric deposition explained differences in DON. Future work will focus on analyzing isotopic values of riverine NOx and DON to aid in further identification of the sources of N reaching the stream.

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USE OF SEAWIFS, MODIS, AND MERIS IN DEVELOPING WATER QUALITY NUMERIC CRITERIA FOR FLORIDA’S COASTAL WATERS

Human activities on land often increase nutrient loads to coastal waters and may cause increased phytoplankton production, algal biomass, and eutrophication. The U.S. Environmental Protection Agency determined that numeric criteria were necessary to protect Florida’s coastal waters from the impacts of anthropogenic nutrients. Coastal waters are defined here as marine waters up to 3 nautical miles from shore, excluding semi-enclosed waters generally defined as estuaries. Florida’s coastal waters have not been monitored comprehensively via field sampling therefore traditional monitoring data are insufficient to support numeric criteria development. However, satellite remote sensing had the potential to provide more extensive data. Spatial and temporal measurements of SeaWiFS, MODIS, and MERIS chlorophyll-a (Chl-a, mg m-3) were resolved across Florida’s coastal waters between 1997 and 2010. These derived values provided a quantitative baseline that could be used to protect against long-term changes in chlorophyll-a resulting from anthropogenic nutrients. The objective of this study was to evaluate an approach for calculating numeric criteria for Florida’s coastal waters in the absence of adequate field monitoring data.

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INFLUENCES OF LANDSCAPE AND HYDROLOGIC MIXING ON RIVERMOUTH ECOSYSTEMS OF THE LAURENTIAN GREAT LAKES

Rivermouth ecosystems in the Laurentian Great Lakes are mixing zones where lake and tributary waters combine to form biologically productive areas analogous to marine estuaries. Complex hydrogeomorphology of rivermouths creates diverse habitats that support diverse ecosystem processes (e.g., nutrient cycling, larval fish nurseries). An improved scientific framework for characterizing these processes across the full range of rivermouths is needed for successful management and restoration. We used existing data to create conceptual models that highlight four zones within the rivermouth (lower river valley, delta, receiving basin, and lake plume) and evaluate variability in large-scale environmental drivers. These models guided 2011 field investigations that characterize the biophysical structure (e.g., mapping of water movements and biota) and ecosystem processes (e.g., nutrient dynamics, food web structure) of three intensely studied Lake Michigan rivermouths: the Ford (minimal impacts), Pere Marquette (moderate impacts), and Manitowoc (highly altered) rivers. Watershed characteristics explained most among-system differences in water chemistry. Within-system temperature and water-chemistry data indicate that hydrologic regime (lake-level fluctuations, river discharge) influences mixing and hydrodynamics and structures physical and chemical habitat. Our highly altered rivermouth (Manitowoc) was characterized by few larval fish and low leaf litter deposition rates. Areas with high leaf litter in the Pere Marquette and Ford contained large macroinvertebrates (e.g., burrowing mayflies). Dissolved and particulate nutrient inputs from rivers seem to be much greater than lake inputs, but lake-derived nutrients often are incompatible with rivermouth consumers at rates equal or greater than riverine nutrients. These data are being used to improve our understanding of how ecosystem structure and function are connected in rivermouth systems.

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COMPARING ALGAL CHLOROPHYLL SPATIAL PATTERNS WITHIN AND BETWEEN GULF AND EAST COAST NATIONAL ESTUARINE RESEARCH RESERVES

Since 2002, we measured water reflectance spectra and conducted simultaneous sampling of water for bulk optical properties (chlorophyll, CDOM, and seston) and other water column properties at greater than 300 stations in more than 25 estuaries and adjacent coastal waters within and proximate to seven NOAA-NERR and one NMS sites located between Texas and Delaware. In most cases, our sampling was coincident with nutrient and carbon speciation analysis and with aerial hyperspectral imagery collections using the Univ. of Nebraska - CALMIT AISA Eagle sensor. Across all stations, the average, median, and ranges for chlorophyll were 2.2, 1.3, and 0.2-4.9 mg/m3, for CDOM abs (440 nm) were 3.25, 3.30, and 0.0-21.1 m-1, and for seston were 33.8, 16.9, and 0.6-726.3 mg/L dry wt. Sites in Texas and Mississippi had the lowest chl averages, Florida, Georgia, and South Carolina sites were intermediate, and Maryland and Delaware the highest values and chlorophyll and nutrient levels were largely correlated across these coastal sites. Within river to estuary to offshore transects, chl generally peaked in the lower reaches of the estuary. Recently, we’ve also begun mapping longitudinal patterns within estuarine drainages using a boat-borne multi-instrument sonde (including chl fluorometer and turbidimeter), water reflectance with a bow-mounted fiber optic light guide and foreoptics, and high resolution GPS track logging. High spatial resolution mapping in the Duplin River tidal watershed of the Sapelo Island NERR revealed several fold greater chl concentration in tidal creeks draining marshes.
model for the Chesapeake Bay that was forced with observed wind, freshwater flow and temperatures from 1990, a wet year, and 2002, a dry year. Based on volumes of appropriate temperature and salinity, juvenile bluefish, bay anchovy, and blue crab had the highest annual volumes of required and optimal habitat, while striped bass and Atlantic sturgeon juveniles had the lowest annual volumes. Reductions in available habitat occurred for almost all species from the wet year to the dry year, with striped bass juveniles experiencing a 42% loss of habitat and Atlantic sturgeon a 62% loss. All species showed a reduction of potential habitat in the presence of low dissolved oxygen, with more significant reductions evident during the wet year. Atlantic sturgeon juveniles were the most sensitive to hypoxia with a 36% decrease in available summertime habitat followed by striped bass with an 18% decrease. Juvenile bluefish, bay anchovy, and blue crab were more resilient with reductions less than 10%. Model results indicate there is significant variation in potential habitat between species and years. The model will be applied with past and future climate change and nutrient loading scenarios to quantify potential impacts on the suite of species.

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**HUMBOLDT BAY INITIATIVE: ECOSYSTEM-BASED MANAGEMENT IN A CHANGING WORLD**

The Humboldt Bay Initiative promotes a collaborative, participatory process to develop and disseminate scientific information about coastal ecosystems; advance communication, collaboration, and activities that enhance ecosystem health; and promote ecosystem-based management. The initiative participants are implementing a climate change adaptation strategy from their 2009 strategic plan. The strategy increases the capacity of the coastal community to deal with the consequences of climate change. It addresses threats to existing habitats, infrastructure, and the livelihoods of coastal communities associated with climate change through the appropriate use of scientifically robust tools and methods. Recently acquired coastal habitat maps and use of existing data for localscenarios and modeling are providing fundamental information to assess connectivity between bay and inland habitats, restore connectivity between the coastal plain and estuarine habitat to allow for sea level rise without harming human communities and to accommodate the migration of habitats and species.

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**MONITORING THE TEMPORAL AND SPATIAL VARIABILITY OF PHYTOPLANKTON AT SPECIES LEVEL USING A COMBINATION OF MEASURING BUOYS, PIGMENT ANALYSIS AND FAST SCREENING MICROSCOPY**

A two years baseline survey of marine fauna and flora including plankton has been conducted in the Fehmarnbelt estuary located in the transitional area between the Baltic Sea and Kattegat in connection to establishing a fixed link across the Fehmarnbelt. The main purpose of the plankton baseline investigations was to characterise the large scale environmental situation before the construction work and to provide calibration data for ecosystem models used for the baseline description and impact assessment. Combining automated fluorescence measurements conducted from anchored buoys with monthly collections of water samples the temporal and spatial variability of phytoplankton populations was determined in the Fehmarnbelt area. The automated fluorescence measurements provided information on the variability of the phytoplankton biomass at three fixed stations and in three depths. On the monthly in situ sampling carried out at 12 stations phytoplankton pigment analysis by High Pressure Liquid Chromatography (HPLC) was used as a fast, very sensitive and precise method for determining the composition and biomass of the phytoplankton groups. Furthermore, the pigment method was combined with fast screening of the samples in the microscope to determine the dominating species present. This combination of methods proved advantageous and cost effective for providing the desired information on the blooming events, the duration of the blooms, the overall succession in the phytoplankton communities as well as for obtaining specific information on the dominating species presents both temporally and spatially in the investigation area.

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**MODELING POTENTIAL HABITAT FOR CHESAPEAKE BAY LIVING RESOURCES**

The frequency, duration, and extent of hypoxia and anoxia in the Chesapeake Bay have increased as a result of anthropogenic nutrient loading and subsequent eutrophication. This study examines the reduction in potential habitat for a suite of Chesapeake Bay species due to hypoxia, anoxia, and environmental variability. A habitat volume model was used to calculate the daily and annual volume of potential habitat based upon a species’ physiological tolerances to temperature, salinity, and dissolved oxygen. Preliminary simulations were conducted with output from a coupled hydrodynamic and biogeochemistry model.
Societies, Estuaries & Coasts: Adapting to Change

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IMPACT OF HYDROCARBON CONTAMINATION ON NITRIFICATION-DENITRIFICATION PROCESSES IN JUNCUS ROEMERIANUS AND SPARTINA ALTERNIFLORA SALT MARSHES

Salt marshes along the Gulf of Mexico experience frequent and damaging effects of hydrocarbon contamination associated with oil development. Oil contamination may affect rates of coupled nitrification-denitrification (CND) in coastal wetlands, thereby affecting nitrogen cycling and nutrient retention. To examine impacts of oil contamination on CND reactions within different vegetation types, I conducted a field study and complimentary greenhouse study in coastal wetlands dominated by common salt marsh species, Juncus roemarianus and Spartina alterniflora. Study sites include Grand Bay National Estuarine Research Reserve, MS, and Point Aux Pins, AL, both of which were affected by the Deep Horizon oil spill in April 2010. We conducted an in situ NH4+ tracer study with three replicate plots per vegetation type over five collections dates. The rate of nitrogen retention and loss via CND were determined by analyzing nitrogen concentrations, in addition to above- and below-ground biomass, prior to and following the 15N injections. In addition, the greenhouse study provides a lens through which field responses under unknown concentrations of oil exposure were evaluated. Vegetated mesocosms containing one of the two plant species and exposed to one of three oil addition treatments (none, low, and high) were injected with 15N label to quantify the rate of CND over a 5 day period. Rates of nitrogen retention and loss were determined from processed biomass, sediments and water.

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MACROALGAL BLOOMS IN A HEAVILY URBANIZED AREA OF SOUTH FLORIDA

In coastal ecosystems worldwide, macroalgal blooms are a known response to excess nutrient input. However, understanding the triggers of these blooms is one of the biggest challenges managers are facing. Macroalgal blooms in South Florida have become a reoccurring issue in the last century as anthropogenic influences have become more prevalent with increasing populations. Currently, Biscayne Bay is experiencing an algal bloom of Anadyomene species complex, in an area that has been heavily influenced by the Horizon oil spill in April 2010. We conducted an in situ NH4+ tracer study with three replicate plots per vegetation type over five collections dates. The rate of nitrogen retention and loss via CND were determined by analyzing nitrogen concentrations, in addition to above- and below-ground biomass, prior to and following the 15N injections. In addition, the greenhouse study provides a lens through which field responses under unknown concentrations of oil exposure were evaluated. Vegetated mesocosms containing one of the two plant species and exposed to one of three oil addition treatments (none, low, and high) were injected with 15N label to quantify the rate of CND over a 5 day period. Rates of nitrogen retention and loss were determined from processed biomass, sediments and water. The results of these studies provide a well-rounded and comprehensive understanding of oil impacts and species-specific differences in CND processes, with important implications for nutrient cycling and nutrient retention in coastal wetlands.

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MULTI-DECADAL MAPPING EFFORTS OF OYSTER (CRASSOSTREA VIRGINICA) REEF DISTRIBUTIONS IN SOUTH CAROLINA, USA: APPLICATIONS FOR CURRENT AND FUTURE NATURAL RESOURCE MANAGEMENT

In South Carolina, extensive tidal creeks and intertidal flats support ecologically- and economically-important oyster populations. Accurate information that tracks changes in the distribution and areal extent of this resource is becoming more critical as coastal development and sea level rise begin to impact these shoreline habitats. Over the past century three major oyster mapping efforts have been undertaken. In the 1990s, survey maps of reef locations and transect lengths were compiled, while the mid 1980s ground assessment included reef area and additional attributes. Since 2003, the SC DNR, in collaboration with the NOAA CSC and USGS, has used geo-rectified multispectral ¼ m resolution digital aerial imagery and GIS applications to conduct a state-wide assessment of the distribution and areal extent of South Carolina’s intertidal oyster reefs. The accuracy of this latest assessment is being further enhanced using high resolution (20 megapixel), low altitude (< 400ft) imagery captured from a helicopter. Here we present comparisons between 1980s and contemporary oyster distribution maps for three areas in South Carolina to illustrate the effectiveness of this approach for identifying changes in oyster distribution. Changes in oyster reef distribution were clearly visible and in many cases differences in the acreages of reefs could be accurately quantified. The current imagery in conjunction with the development of GIS-based analytical tools creates the potential to investigate large-scale spatial relationships between anthropogenic activities, changes in land use and the status of our natural resources (primarily in this case oyster reefs). Our latest maps represent a valuable tool for both current and future resource management with applications for change analysis and provide the opportunity for the maintenance of an up-to-date statewide database for oyster reef distribution.
THE INFLUENCE OF TURBIDITY CURRENTS AND GEOMETRY ON THE TRAPPING OF SEDIMENT IN AN ESTUARY

In many estuaries high sediment concentrations are observed. Examples of such estuaries are the Ems and Humber estuary (Europe) and the Yellow river (China), where concentrations up to tens of grams per liter are observed. First, the location of the estuarine turbidity maximum in the Ems estuary (and its change in location over the years) is investigated using an analytical 2DV model. The water motion is modeled by the width-averaged shallow water equations, and the concentration is obtained by solving the width-averaged advection-diffusion equation. The density depends on salinity and suspended sediment concentration. The salinity profile is prescribed, but the sediment concentration is obtained from the model. The morphodynamic equilibrium condition is used to get the sediment availability at the bottom. When contributions due to turbidity currents are neglected, the trapping of fine sediments can be attributed to tidal asymmetry and temporal setting lag effects. Including turbidity currents, it is found that the location of the turbidity maximum (ETM) shifts slightly to the seaward side. Furthermore, the width of the ETMs increases, resulting in turbidity zones instead of well defined maxima. The mechanisms resulting in these changes will be explained. Furthermore, the influence of geometrical parameters (such as length, bathymetry, etc.) on the trapping of sediment are investigated. It turns out that length of the estuary, compared to the frictional length of the first overide, determines whether sediment can be imported into the estuary, or is mainly trapped at the entrance. If the estuarine length is smaller than the M4 frictional length, sediment is imported. If the length of the estuary exceeds this frictional length, transport due to tidal asymmetry is not strong enough and sediment is trapped close the upward limit of salt intrusion. Using analytical model results, this sensitivity to estuarine length will be discussed.

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SUITEABILITY OF LIVING REEF SITES WITH RESPECT TO OYSTER MORTALITY, GROWTH, AND CONDITION: INTER AND INTRA-SITE VARIABILITY IN OYSTER POPULATION VIABILITY

Along the northern Gulf coast of the U.S., reefs created by the eastern oyster, Crassostrea virginica, are increasingly targeted for restoration. Living reefs may provide a variety of ecosystem services including shoreline stabilization, enhanced fisheries production, water filtration, and sequestration of carbon. What remains a challenge is our ability to predict the success of developing a viable reef system in different settings; the establishment of a viable oyster population is inherent to the success of any project. Working at two different scales, we are currently comparing the viability of different settings for supporting sustainable oyster populations. Oyster mortality, growth and condition are being compared (1) between three environmentally-different sites across Louisiana's Gulf coast (Vermilion Bay, Grand Isle, Sister (Caillou) Lake), and, (2) between different areas within one site (Sister Lake, LA: north, west, south sides). Using caged oysters deployed at all sites, we compared recruitment, growth, mortality and condition, examining site specific variables to examine differences. For the inter-site comparison, cages were deployed in February 2011 and data presented only represent the first 6 months. While Vermilion Bay oysters experienced high mortality (~90%) and low growth, both Grand Isle and Sister Lake have experienced low mortality (~20%) and relatively higher growth rates (> 3 mm mo-1). The Sister Lake intra-site comparison represents data collected since February 2009 and indicates significant differences in recruitment, mortality, growth and effects of the resulting on-reef population structure. Understanding what factors affect the establishment of viable and sustainable oyster populations is critical for reef restoration and living shoreline projects; ecosystem services to be expected for restored reefs are ultimately dependent on the establishment of a viable oyster population.

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EFFECTS OF SEDIMENT ORGANIC MATTER CONTENT ON MORPHOLOGY AND LIGHT REQUIREMENTS OF ZOSTERA MARINA (EELGRASS)

Experimental and observational studies have determined that many seagrass species, including Zostera marina (eelgrass), require ~22% of incident light for sustained growth and meanging development. Water quality parameters including levels of suspended sediments, chlorophyll and dissolved organic matter can impact the ability of light to penetrate the water column. As a result, restoration and management of seagrass ecosystems are often focused on establishment of water quality criteria aimed at achieving minimum water column light levels of 22% of incident light. Today, there is growing recognition that the maximum depth of seagrass growth predicted based on water column light penetration is often not observed, and that the simple relationship between underwater light penetration and a single minimum light requirement for a particular seagrass species is not sufficient to predicted habitat suitability in all areas. Recent studies have suggested that sediment organic matter content, sediment grain size and hydrogen sulfide concentrations in the seagrass rhizosphere can impact the minimum light requirements in part by altering plant morphology. Changing land use patterns and eutrophication resulting from coastal development have the potential to impact these sediment characteristics, and thereby alter seagrass distribution and abundance. The results of a mesocosm study conducted on the Eastern Shore of Virginia and designed to test the synergistic effects of sediment organic matter content and light availability on eelgrass survival, growth and morphology will be discussed.

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BUILDING THE FIELD OF CLIMATE CHANGE ADAPTATION THROUGH CLIMATE ADAPTATION KNOWLEDGE EXCHANGE (CAKE): CASE STUDIES IN FLORIDA

Although the concept of climate change adaptation is rapidly becoming a part of the conservation lexicon, the practice of natural resource planning and management around climate change is still developing. There is an increasing need for the exchange of information on successful adaptation strategies and tactics. This talk will present EcoAdapt efforts to survey, inventory, and assess adaptation projects from different regions, jurisdictions, and scales throughout North American marine and coastal environments. It will provide context on how climate change is being addressed in conservation and management through an online resource, the Climate Adaptation Knowledge Exchange (CAKE, www.cakex.org). CAKE is a joint effort by EcoAdapt and Island Press to create an innovative community of practitioners on climate change adaptation. This presentation will also showcase the different components of CAKE, including: the availability of a georeferenced database of adaptation case studies, a directory of adaptation-engaged individuals, a virtual library of resources that can support adaptation efforts, advice for conservation and information exchange, and links to tools and data that are available to support and build the adaptation community. CAKE will be used to highlight several adaptation case studies in Florida. Particularly the “Florida Reef Resilience Program” and the “Climate Change Action Plan for the Florida Reef System.”
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MOVING FROM THEORY TO PRACTICE IN INTEGRATED ECOSYSTEM ASSESSMENT

Changes in ecosystem condition may result from a variety of causes, ranging from “natural” (i.e. non-anthropogenic) events (such as earthquakes) through coupled natural-anthropogenic events (such as hurricanes, sea-level rise, and climate variability) to predominately anthropogenic events such as hydrological modifications, population growth, or habitat alteration. In particular, U.S. coastal population growth is several times higher than in the rest of the U.S., and coastal sprawl is consuming land at three or more times the rate of population growth. These trends are projected to continue, requiring managers to consider both economic development and ecosystem conditions in a search for the balance that will hopefully allow for the sufficient maintenance of both. To attempt to reach this goal, numerous authors and agencies have stated the need for interdisciplinary and/or supradiplinary decision making processes such as integrated ecosystem assessment (IEA). The difficulty, however, lies in moving from theoretical constructs concerning the form for an IEA to its implementation in addressing actual complex environmental issues. This session will explore the application of IEA to address coastal environmental issues with particular focus on the application of conceptual modeling and the Integrated Assessment and Ecosystem Management Protocol in the IEA process.

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INTEGRATING RISK ASSESSMENT OF ENVIRONMENTAL STRESSORS WITH IMPACTS ON ECOSYSTEM SERVICES AND HUMAN HEALTH

Numerous natural and man-made stressors may adversely affect coastal ecosystems leading to impacts on environmental quality and habitat condition as well as impacts to human health. Impacts of stressors from urban and agricultural pollution as well as climate change may often co-occur, presenting challenges for assessing impacts of cumulative risks from these different classes of stressors. Development of conceptual models such as Conceptual Ecosystem Models (CEMs) that accurately portray and estimate risks are critical in defining accurate holistic risk assessment frameworks for assessing impacts of coastal pollution on ecosystem health. Similarly, the use of Combined Ecological-Social Systems Models (CESSMs) that include human services such as human health, may provide a mechanism for complementing traditional CEMs focus on non human ecosystem services risk. Conceptual models are presented for assessing cumulative stressor impacts from agricultural pesticides and pollution from urbanization (chemical pollution, microbes and nutrients) on coastal ecosystems and human health along with how these models may be adapted to better accommodate and predict impacts from climate change. Public engagement and consensus building in the face of complex and often conflicting scientific information is critical to this process in developing a precautionary approach to risk assessment and environmental management.

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BETWEEN THE RIVER AND THE DEEP BLUE SEA: HOW FRESHWATER LIMITATIONS AGGRAVATES SEA LEVEL RISE IMPACTS

Along Florida’s coastlines, scientists are documenting dramatic changes in ecosystems as a result of a combination of reduced freshwater input and sea level rise. The interplay between fresh and salt water are critical to the sustainability and functioning of many coastal ecosystems. We highlight two case studies along Florida’s Big Bend coast- oyster reefs and fresh and salt water are critical to the sustainability and functioning of many coastal ecosystems. We explore local policy makers to improve freshwater availability to coastal ecosystems.

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SEASONAL CARBON CYCLING IN FRESHWATER WETLAND SEDIMENTS: ANALYSIS OF MICROBIAL ACTIVITIES, LIPID BIOMARKERS, AND ISOTOPE GEOCHEMISTRY

Freshwater wetlands are the single largest natural source of atmospheric methane, a major greenhouse gas. In anoxic sediments, methane is one of the terminal products of organic matter mineralization. As global temperatures rise, a potential positive feedback exists between global warming and the production of this powerful greenhouse gas in sediments. This study explored seasonal variations in the dominant pathways (e.g. methanogenesis and sulfate reduction) of terminal metabolism in a freshwater wetland in Georgia. We determined distinct seasonal variations in methane production rates and pathways as evidenced through geochemical profiles and microbial rate assays. Despite the perennially low sulfate concentrations in the porewaters, sulfate reduction rates exceeded those of methanogenesis throughout the year. Rates of anaerobic methane oxidation (AMO) were high and together with atmospheric methane fluxes from the sediment, methane consumption often exceeded methane production in the top 40 cm of sediment. These variations in carbon flow were reflected in the stable carbon isotopic signatures of methane and the two major methanogenic precursors: acetate and dissolved inorganic carbon. Intact poly membrane lipid analyses revealed a diverse microbial community which varied with depth and season.

In contrast to previous studies based in rice fields and lake sediments, our results indicate that temperature alone is not the major driver of the observed shifts in methanogenic pathways. We will present a combination of porewater profiles, rate assays, biomarker, and isotopic data to illustrate the variations in carbon cycling in these freshwater sediments and the possible mechanisms behind them.

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THE ROLE OF AN INTERRUTTENTLY CLOSED, NORTHERN CALIFORNIA ESTUARY FOR THE FEEDING ECOLOGY OF JUVENILE STEELHEAD

A new focus has been placed on estuaries as a potential rearing habitat for juvenile Oncorhynchus mykiss, once thought only to be utilized as a corridor for migrating to the ocean. Previous research (2008) by Hayes and Bond has found that steelhead rearing in an intermittently closed small estuary had greater growing opportunities and thus were more successful in their recruitment back to the adult population. The University of Washington, School of Aquatic and Fishery Sciences’ Wetland Ecosystem Team conducted a study from 2009-2010 designed to evaluate how different natural and managed ocean entrance conditions in the Russian River estuary (CA) affect juvenile steelhead growth and ultimate performance as a function of prey availability. Sampling intended to capture the natural ecological responses (prey composition and consumption rate) of juvenile steelhead and availability of their prey resources under naturally variable water level, salinity and temperature stratification in the estuary. A flooded lagoon provides juvenile steelhead and other salmonids the opportunity to feed in peripheral habitats, and potentially allowing for new or expanded prey resources and increased consumption and growth rates. Analyses of the diet composition of steelhead captured in 2009-2010 indicate that epibenthic crustaceans (amphipods, isopods, mysids) and aquatic insects were the typical and dominant prey in most samples. Early observations suggest that when the estuary is open to the ocean, the river currents restrict the invertebrates to the more protective shoreline, limiting the more profitable foraging area for steelhead; when the estuary entrance is closed and becomes a freshwater lagoon, invertebrates can more effectively occupy the entire estuary, increasing the potential rearing habitat for juvenile steelhead. This study will help management decide if an estuary can serve as an alternative rearing habitat for juvenile steelhead.

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THE HUNT FOR PINK SEPTEMBER - POPULATION DISTRIBUTION AND DIVERSITY OF THE POTENTIAL BIOFUEL HALOPHYTE, SEASHORE MALLOW

Seashore mallow, Kosteletzkya pentacarpos, is a brackish marsh plant that grows on the Atlantic and Gulf coasts of the U.S. and in Europe. Because of its value as a potential salt-tolerant biofuel crop for low-lying coastal farmland affected by sea level rise, we are exploring the distribution of populations and the morphological and physiological diversity of this halophyte with the goal of finding selections with characteristics desirable for biofuel production. We identified approximately 900 locations where seashore mallow had been found in the past. We visited about 200 of these and found that only 20% of the current...
This information will be incorporated into a GIS interface so that projects can be easily viewed and searched. A request for letters of intent was released for community-based hydrological restoration projects. Funded projects will address some of the restoration needs identified in the inventory. A monitoring panel will develop criteria to evaluate the effectiveness of hydrological restoration projects in the Gulf of Mexico and will be used for projects funded through this effort. The inventory of restoration projects, status of the monitoring criteria, and other outputs associated with this partnership will be presented.

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SEA LEVEL RISE VULNERABILITY ANALYSIS FOR PALM BEACH COUNTY, FLORIDA

Coastal communities routinely face hazards from hurricane land fall, including inundation of low-lying areas from storm driven tidal surge. Under future scenarios of climate change, sea level rise could exacerbate this effect, creating even more frequent flooding events even during lesser storms. Even without wind driven tidal surge, rising sea level will cause coastal communities to experience inundation to gradually higher tides over the coming decades. To examine the potential effect of sea level rise on the coastal community of Palm Beach County, Florida, we modeled four possible future scenarios: 3 feet of sea level rise (SLR), and 3 ft SLR plus storm surge from Category 1, 3 and 5 hurricanes, respectively. Community vulnerability to the resulting inundation zones was evaluated along multiple dimensions, including: Critical Facilities, Ecosystems, Economy, Coastal Resources, Water Resources, and Population. The study serves as a planning tool for exploring mitigation options for sea level rise, including armoring shorelines against future inundation, adapting structures to accommodate future inundation, and treating from vulnerable coastal locations.

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HERBIVORY IMPACTS ON A NUTRIENT-ENRICHED FRESHWATER COASTAL WETLAND IN LOUISIANA

The City of Hammond, Louisiana began discharging secondarily-treated municipal effluent into a freshwater wetland in the fall of 2006. At the time discharge began, the wetlands had been isolated from virtually all freshwater inflow from the surrounding watershed for over a half century due to the construction of a spoil bank. Immediately following effluent discharge, a 2006, there was robust growth of herbaceous vegetation. By late fall 2007 the emergent wetlands in the immediate vicinity of the effluent discharge began to decline, and within a year nearly the entire marsh south of the discharge pipe along South Slough had converted to open water or mudflat. By 2010, there had been substantial recovery of the marsh. A number of hypotheses have been presented to explain the conversion of the marsh to open water and mudflat, including increased pH, disease, and reduced belowground biomass and increased soil decomposition due to high nutrients. Intensive field studies provide the most conclusive data that the marsh loss was primarily caused by the introduced rodent, nutria (Myocaster coypus), and that recovery is occurring as a result of aggressive nutria control, indicating that nutria control was essential to recovery of the herbaceous vegetation. Negative impacts were not observed for mature baldcypress growing in the area of discharge, where growth rates were greater than 5 times those of trees not receiving effluent. Increased flooding due to lack of drainage from the area is hindering marsh recovery. Water control structures have been installed that will allow water level drawdown and this should lead to enhanced marsh recovery.

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SPATIAL VARIATION OF LONGITUDINAL DISPERSION COEFFICIENT IN AN ESTUARY

The effective longitudinal dispersion is a primary agent for determining property distributions in estuaries. Previous studies have mostly studied the longitudinal dispersion coefficient for tidal averaged condition. However, information on spatial and temporal variation of longitudinal dispersion coefficient at low and high tides is scarce. Three years of hydrographic data taken at low and high tides along the main axis of the Sumjin River Estuary (SRE), Korea are used to estimate the spatial and temporal variation of this effective longitudinal dispersion coefficient. The ranges of dispersion coefficient values are rather broad at high water slack (HWS) and narrower at low water slack (LWS) due to different...
tidal amplitudes. The spatially varying longitudinal dispersion coefficient has maximal values (>300 m2s-1) over the tidal excursion length at high water and then gradually decreases upstream with fluctuation. The temporally varying longitudinal dispersion appears to be positively correlated with river discharges and salinity gradient at both low and high tides. The salt fluxes are relatively small over the tidal excursion length due to the reduction in a seaward shift of the salinity distribution generating smaller salinity gradient over the region of greater cross-channel flow compared to upstream. By contrast, the transport fluxes increase in the central and inner regimes due to increasing seaward shift of the salinity distribution which increases both salinity gradient and salt fluxes. Estimation of numerical values of the effective longitudinal dispersion coefficient in the SRE can be useful for better understanding distributions of other tracers in the SRE as well for developing and testing hypotheses about various mixing mechanisms.

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INFLUENCE OF ANIMAL AGE AND DIET ON FECAL SHEDDING OF BACTERIOIDAL

The ability to discriminate between bovine and other sources of fecal contamination is necessary for the accurate evaluation of human health risks associated with agricultural runoff from cattle feeding operations. As a result, numerous methods have been developed to characterize bovine fecal pollution in ambient waters. The majority of these methods target genetic markers from enteric Bacteroides microorganisms, largely due to their abundance in the fecal microbial community, close association with the animal host, and short survival times once discharged into the environment. However, it remains unclear how animal age and feeding practices influence Bacteroides population structure, host-associated genetic marker distributions across animal populations, and the performance of fecal source identification methods. Using quantitative real-time PCR and massively parallel pyrosequencing technologies, the density and distribution of bovine-associated genetic markers, as well as Bacteroides population structures were determined from a collection of 658 reference fecal samples. The reference collection consisted of samples collected from animals ranging from neonatal (25 days) to adult (>3 years), four different animal feeding practices, and 12 different geographic locations. Results of these studies suggest that animal age and diet dramatically influence the shedding of fecal Bacteroides including host-associated genetic markers and emphasize the need for further research in this area.

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POTENTIAL IMPACTS OF RESTORED OYSTER REEFS ON SUBMERGED AQUATIC VEGETATION

It has been hypothesized that restored oyster reefs could increase light availability for submerged aquatic vegetation (SAV) leeward from the reef through the filtration of particles floating in the water column and the reduction of sediment resuspension. As part of a large oyster reef restoration project, we are in the process of collecting a suite of variables to test these hypotheses. Namely, we have been measuring water-column light extinction coefficients and amount of light reaching the bottom continuously for one week at mid-distance leeward of four 70m restored reefs constructed hundred meters away from the shoreline and adjacent four control plots (i.e. no reef constructed) before and after reef construction. We are also documenting the number and size (i.e. expansion or reduction) of the SAV patches leeward of the reefs or corresponding oyster-less edge of control plots, along with SAV morphological attributes (i.e. shoot density and leaf length and width). We are also measuring planter of Paris cloid dissolution rate as a proxy of water flow movement. Measurements before reef construction expand 4 months and measurements after reef construction expands 12 months. Thus far we have not found a significant effect of the restored oyster reefs on light penetration through the water-column. Before construction of the reefs, reef-to-be locations and control locations did not show significantly different extinction coefficients and, after the construction of the reefs, that lack of differences persisted. However we have found significant difference in the seagrass variables measured between reefs and controls in some cases which correspond with the dissolution rate of planter of Paris cloids. These results suggest that, in naturally murky waters such as in estuaries and marsh embayment of the Northern Gulf of Mexico, the impact of oyster reef restoration on water clarity may be limited but the physical protection provided by the reefs is more imminent.

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SHOaled IN? METHODS TO MINIMIZE DREDGING IN AN ESTUARINE ENVIRONMENT USING MODELING - PART II

As sediment is transported from the mountains to the ocean it begins to deposit in areas of slow moving current. This most evident in an estuarine system and leads to shoaling problems in navigation channels and ports within the estuary — requiring high costs to remove. However, options exist to prevent the sediment from settling in a specific area once the physical system are understood. This understanding can lead to understanding mitigation measures that can ultimately reduce the cost of channel maintenance. Based on modeling results, it was determined that alignment alone dredging solutions are potentially insufficient at MOTSU. Rather a combination of alignment and dredging alternatives should be used in conjunction to maximize shoaling reduction. Building on Part I this presentation will provide insight into alternative means of shoaling mitigation at MOTSU. As previously described in Part I and shown in the model results, constant shoals prevent full use of terminals along this waterway. Additional complications, both for modeling and dredging, arise in the material matrix found in the shoals at MOTSU, commonly referred to as fluid mud. This matrix of material allows for unanticipated sediment movement and rapid build up of shoals. As such possible alternate alternatives for shoaling mitigation, those other than realignment and dredging schemes, are evaluated. These include approaches such as: passive and active nautical depth; scour jets; and other non-traditional measures applied at alternate locations. Applying these alternate methods along with the most ideal channel configuration, as indicated by the model, researches propose a tiered solution. With the help of the model and incite from other sites the most ideal alternative is presented.

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RECOMMENDED INDICATORS OF ESTUARINE WATER QUALITY FOR GEORGIA

Increasing nutrient input and subsequent eutrophication and hypoxia are concerns in many estuaries, and the U.S. EPA has mandated the development of numeric nutrient criteria to assess the status of U.S. coastal waters. However, they recognize the need for regionally appropriate criteria, as previous national-level efforts have often relied on criteria that are not equally relevant in all waters. Two pathways to eutrophication have been suggested to exist in Georgia waters: the classic phytoplankton-mediated pathway in stratified waters and an alternate pathway in which excess nutrients stimulate microbial respiration directly, resulting in low dissolved oxygen throughout a well-mixed water column. We propose a suite of seven indicators, as well as basic ancillary data (water temperature, salinity, specific conductance), that are intended to help classify and understand the causes of water quality degradation in Georgia. We recommend two immediate indicators of poor water quality (pH and dissolved oxygen) that may indicate that a stressful and potentially lethal condition is already in progress. The remaining five (nitrogen, phosphorus, chlorophyll a, transparency, and biochemical oxygen demand (BOD)) are “early warning” indicators of potentially poor water quality that should be measured in order to anticipate problems and make appropriate management decisions. These indicators, which cover the progression of eutrophication from nutrient over-enrichment to algal overgrowth (if present) to enhanced microbial respiration and hypoxia, will help to ensure that problems will not be missed due to limited sampling frequencies. We present the rationale for choosing these indicators and the considerations for developing evaluation criteria. This work was part of a larger project evaluating the condition of Georgia’s coastal waters for the Georgia Coastal Management Program.

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SPLITTING THE CHECK: DEVELOPMENT OF LOAD ALLOCATION RULES FOR THE MULTI-STATE CHESAPEAKE TMDL

The Chesapeake Bay TMDL requires significant reductions in nitrogen, phosphorus, and sediment to meet water quality standards. The federal government and the seven states plus Washington DC that make up the watershed all have separate commitments under the TMDL to make these reductions. The Chesapeake Bay Program Partnership used linked atmospheric, watershed, and estuarine models along with input from stakeholders to arrive at a reasonable allocation method. This allocation method took into account the ability of each jurisdiction and sector to make load reductions, the relative position of each jurisdiction in the watershed, the relative position of the point of entry of the loads to the estuary from each jurisdiction, and the benefits derived from a restored bay.
HOW DOES TEMPERATURE AFFECT THE STARVATION RATE OF THE DAGGERBLADE GRASS SHRIMP PALAEMONETES PUGIO INFECTED WITH THE BOPYRID ISOPOD PROBOPYRUS PANDALICOLA?

The daggerblade grass shrimp Palaeomonetes pugio is prevalent along the East Coast of the United States and is an integral part of the estuarine food web. Palaeomonetes pugio transfers energy between trophic levels by feeding on epiphytes, macrofauna, and meiofauna. In addition, Palaeomonetes pugio is a food source for many commercially important species such as the blue crab Callinectes sapidus and the red drum Sciaenops ocellatus. Probopyrus pandalicola is a bopyrid isopod that infects Palaeomonetes pugio and decreases the energy available to its host by feeding on the hemolymph of the shrimp. The purpose of the present study was to determine if Proxobopyrus pandalicola had an effect on the starvation rate of Palaeomonetes pugio at different temperatures. Six trials were conducted between September 2009 and June 2011. For each trial, 75 shrimp (50 parasitized and 25 unparasitized) were collected from Country Club Creek and Moon River in Savannah, Georgia. Parasites were removed from 25 of the 50 parasitized shrimp with forceps for the deparasitized treatment. The initial length, weight, and trematode count were recorded for each shrimp. Parasitized shrimp (n=25), unparasitized shrimp (n=25), and deparasitized shrimp (n=25) were then placed into individual aquaria and starved until 100% mortality occurred. Starvation rates shrimp (n=25), unparasitized shrimp (n=25), and deparasitized shrimp (n=25) were then placed into individual aquaria and starved until 100% mortality occurred. Starvation rates were compared using a Student’s t-test. Parasitized shrimp survived less time than both deparasitized and unparasitized shrimp; however, the effect of the isopod was only significant for trials conducted at a higher temperature (26°C). Therefore, cooler temperatures may slow the metabolism of the shrimp and reduce the effect of the isopod parasite on the shrimp host.

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INCORPORATING RESILIENCY INTO HABITAT RESTORATION PLANNING IN TAMPA BAY

Coastal habitat restoration goals have been developed in the Tampa Bay watershed under the management paradigm of “Restoring the Balance” of habitat accrages to proportions observed in the 1950s. Although progress has been made to re-establish these proportions within the watershed since inception of the Tampa Bay Estuary Program (TBEP) in 1991, the potential impacts of climate change and sea level rise (SLR) on coastal habitat restoration and preservation have been identified as new challenges in meeting the “Restoring the Balance” goal. With this in mind, the TBEP is currently engaged in two pilot EPA estuary studies that will investigate the effects of climate change and SLR on critical coastal habitats and the services they provide to develop future adaptation and resiliency strategies for the region. The first study, in association with an EPA Climate Ready Grant, is focused on identifying vulnerabilities of coastal habitats to projected SLR using SLAAM projections within the watershed and determining strategies (e.g., creating habitat refugia) to deal with the potential losses of critical coastal habitats. The second study, the Tampa Bay Ecosystem Services (ES) Demonstration Project, will investigate changes in ES valuations associated with climate change and SLR. Both studies will result in the development and application of web-based tools that land use managers and planners can use to inform decision making. Additionally, information from both these studies will be incorporated into a Gulf Coast handbook as an example of Tampa Bay’s local adaptation strategies that incorporate resiliency into habitat restoration planning in the face of climate change and SLR.

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EELGRASS SURVIVAL WITHIN TWO CONTRASTING SYSTEMS IN THE MID-ATLANTIC: THE CRITICAL ROLE OF SUMMER TEMPERATURE

Long term studies on annual eelgrass (Zostera marina) patterns in the mid-Atlantic region of the USA have shown complex changes, including both increases and decreases, with recovery from losses in the 1930s varying greatly between the coastal lagoons and the Chesapeake Bay. Since 2000, seed-based restoration efforts in the coastal bays of Virginia introduced eelgrass back to this system, and bed expansion has averaged 117% per year. In contrast, the York River, a tributary in the lower Chesapeake Bay, has on average experienced no expansion throughout this same time period, and has undergone two significant die-off events in 2005 and 2010 during periods with unusually high summer temperatures. We used a temperature dependent growth model to show that from 2005-2010, coastal bay populations received at least 100% of their light requirements 24% of the time, while York River populations only received this 6% of the time during the summers. Analyzing summer temperatures from continuous recording YSI’s at both areas in 2010 suggests that the greater tidal range and proximity of the coastal bays to cooler ocean waters may be an important influence on the distribution of exposure to stressful conditions. Our analyses suggest a difference of only 1-2°C during periods when temperatures exceed 28°C can determine the critical threshold between survival and death in these perennial populations. Our data are important in the debate surrounding the implications of climate change for plant and animal populations as it influences the overall temperature regime in this region. These temperature scenarios suggest that without an increase in available light, Chesapeake Bay populations may be severely reduced or possibly eliminated while coastal bay populations, because of their location to cooler Atlantic waters, may become the refuge populations in this region.

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EELGRASS GENETICS AND RESILIENCE IN SOUTHERN NEW ENGLAND AND NEW YORK TO SUPPORT MANAGEMENT AND RESTORATION SUCCESS

A database of genetic and several physical and biological parameters pertaining to eelgrass (Zostera marina L.) was created to advance management and restoration science in coastal waters of southern New England and New York. We assessed the population structure, genetic diversity, and gene flow of eelgrass across the region using an experimental factorial design of potential stress parameters to yield maps of eelgrass distribution and resilience and a database of its multiple stressors. Nine microsatellites were used to genotype populations, and evaluate metapopulation structure along these coasts to identify the resilience of eelgrass in the region. All populations showed a high degree heterozygosity with higher amounts at several Massachusetts and Connecticut sites. Rhode Island eelgrass populations showed more genetic structure than other states in the region. Genetically distinct eelgrass populations with unique alleles were re-sampled for subsequent experimental mesocosm experimentation testing of the stressor response of these eelgrass clones to reduced light, increased temperature, and organic enrichment of sediments. We combined: 1) evaluation of the genetic differentiation of eelgrass populations in southern New England and New York; 2) detailed geographic studies of eelgrass genetic variation and resilience; and 3) experimental testing of plant tolerances which included multiple stressor spatial data based on mesocosm experiments. Our study advances management and restoration science by providing information on environmental parameters and stressors to eelgrass needed to improve site selection for restoration; second, by identifying genetically diverse populations of eelgrass to improve restoration success; and third, by creating a geographic database of eelgrass distribution, genetic diversity, and population resilience for management application.

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A BENTHIC HABITAT HETEROGENEITY MAP FOR NARRAGANSETT BAY, RHODE ISLAND

Between 2004 and 2011, the Narragansett BayMap Project has collected over 200 square kilometers of swath acoustic data to serve as the foundation for subtidal benthic habitat and cultural resource maps. A primary goal of the project is to determine the variety and extent of benthic habitats within Narragansett Bay, both geologically and biologically. Previous characterizations of subtidal benthic habitats in Narragansett Bay have relied on aerial photography (e.g., eelgrass bed mapping) and/or the interpolation of species abundances between discrete bottom sample locations. In our approach towards a continuous bay-wide benthic habitat map, we first created bay-wide side scan sonar and bathymetry mosaics, reflecting the bay’s broad-scale surface geomorphology. We then used the standard deviation in side scan sonar backscatter intensity to reflect benthic habitat heterogeneity. This approach separated flat, “featureless” areas of bayfloor from areas that had more geological and/or biological relief (e.g., cobble habitat, mussel beds). Preliminary ground-truthing of the different zones of heterogeneity included sediment profile images and grab samples, with future work incorporating underwater video transects.

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NEW YORK TO SUPPORT MANAGEMENT AND RESTORATION SUCCESS
OIL-DRIVEN DIE-OFF OF LOUISIANA SALT MARRSHES FOLLOWING THE DEEPWATER HORIZON OIL SPILL

In 2010 the BP Deepwater Horizon MC 252 oil spill released over 850 million litres of crude into the Gulf of Mexico. Although one year has passed, we still have little understanding of its ecological impacts. Here, we show that in Louisiana salt marshes death of plants and animals occurred in areas with heavy covering by MC 252 oil residues, overwhelmingly within 15m of the shoreline. Death of salt marsh plants appeared to be due primarily to smothering, as plants with light oil coatings survived indefinitely. Salt marshes also exhibited resilience to oil disturbance, as clonal regrowth began within 6 months from adjacent healthy areas. However, erosion rates along marsh edges increased by over 2-fold in die-off areas, challenging the widely held theory that salt marshes will not experience long-term impacts from oil spills and revealing decline of shoreline protection services as one consequence of this large-scale disturbance.

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PRODUCTIVITY MEDIATES A CROSS-Ecosystem TROPHIC CASCADE

In salt marsh ecosystems, aquatic and terrestrial food webs are connected through predators such as dragonflies and damselflies that spend their larval period in water but hunt in terrestrial habitats as adults. The role of these predators in salt marsh food webs is unknown, as is the effect of productivity in productivity. Sixty four 1m x 1m plots of the sea oxeye daisy, Borrichia frutescens, were established near a natal creek from which odonates (primarily Enallagma civile) emerged. Half of the plots were located in an area of high productivity (i.e. soil fertility and biomass production) and half were located in an area of low productivity. In each area, half of the plots were caged to exclude predators. Exclusion of E. civile damselflies resulted in a significant increase in the densities of the most common insect herbivores of B. frutescens. The higher herbivore densities subsequently resulted in reduced growth and performance of the plants. These effects, however, were only observed in the high productivity area. These results demonstrate that cross-ecosystem trophic cascades can be important in coastal systems, but their importance may be mediated by productivity.

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CHALLENGES AND INCENTIVES OF SCIENTIFIC GUIDANCE FOR ECOSYSTEM PROCESS BASED RESTORATION: THE PUGET SOUND NEARSHORE ECOSYSTEM RESTORATION PROJECT (PSNERP) EXPERIENCE

A scientific foundation is generally assumed, but not necessarily implemented—much less realized—in planning estuarine and coastal restoration programs and projects. While providing the opportunity to effectively meet restoration goals, the level of investment and capacity required to sustain an interdisciplinary approach can create considerable impediments. Since 2002, the Nearshore Science Team (NST) of the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) has provided scientific guidance for planning ecosystem restoration and protection of the ~4,000 km2 Puget Sound, Washington, shorelines. Perhaps the NST’s foremost challenge has been advancing the scientific bases for process restoration, overcoming traditional structure-based approaches. An equal challenge has been furthering the principles of restoring biophysical processes for the delivery of ecosystem functions, goods and services, which despite ubiquitous lip-service continues to be an uncomfortable currency for restoration among both implementing institutions and the public. After a decade of advancing ecosystem science in PSNERP, the NST’s “lessons learned” highlight the importance of (a) adopting a program-specific conceptual model, (b) advancing approaches and tools for restoring ecosystem processes, (c) documenting historic change and qualifying the consequences in terms of impairment of ecosystem goods and services, (d) incorporating a landscape-scale perspective that incorporates cumulative effects, (e) integrating protection and protection, (f) validating assumptions and analyses with best available, and preferably published, science; and, (g) embedding transparent, external peer review. Even in a complex socio/political setting for restoration of extensively modified and occupied ecosystems, the NST experience has indicated that respect for rigorous science can overcome inherent uncertainties in restoration, entrenched institutions, and antiquated policies and approaches.

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ASSESSING INTERACTIVE EFFECTS OF EELGRASS AND OYSTER RESTORATION ON INVERTEBRATE COMMUNITY ESTABLISHMENT

The importance of seagrasses and oyster reefs as a foundational species that support myriad others is a major motivation for restoration of shallow water benthic habitats. Restoration of both eelgrass (Zostera marina) and substrate to support native oystes (Ostrea lurida) in the San Francisco Bay is expected to be beneficial in providing refuge, as well as food resources for native fishes. The assemblage and functions that develop in particular habitats may be influenced by adjacent habitats, as epifaunal invertebrate species can play important and
often unique roles in shallow benthic habitats. We conducted a field experiment with replicate plots of eelgrass only, oyster reef only, and eelgrass plus oyster reef, to test whether invertebrate species composition, density, and total abundance differed on eelgrass or oyster reefs when alone versus when in close proximity to the other habitat. Ten months after the experiment began, suction sampling revealed a significantly greater number total of invertebrates (and a trend toward greater species richness) on eelgrass in the eelgrass plus oyster reef plots than in the eelgrass only plots. Differences were largely due to increased numbers of bivalves, gastropods, and amphipods. Abundances of invertebrates were 2-3x lower on oyster reefs than on eelgrass, and presence of eelgrass in plots did not lead to greater numbers on the oyster reefs. These results suggest that the presence of oyster reef facilitates establishment of invertebrates on eelgrass. While eelgrass did not favor establishment on oyster reefs, restoration projects that include both habitats could increase invertebrate densities over what would be available with oyster reef restoration alone.

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CHANGES IN GRAIN SIZE SPECTRA AND FLOC CONTENT OVER TIME IN A MACROTIDAL SALT MARSH RESTORATION SITE

One of the indicators of success of a salt marsh restoration project is if the site is trending towards conditions present at a reference site. Several factors influence the soil characterizations at each sample location. These factors include source material, the elevation of the site within the tidal frame, distance from the estuary’s mouth, distance from the creek bank and flow velocity. The grain size spectrum of a sample location is influenced by source material and velocity of current. The purpose of this project is to explore changes in source material and hydrodynamic processes in a restoration site over time with the use of disaggregated grain size (DIFS) analysis. It is hypothesized that over time the differences in source material and hydrodynamic processes at the restoration site will become minimal. The research was conducted within a newly restored salt marsh (and associated reference site) in the upper Bay of Fundy currently being monitored as a compensation project. Cores were taken from the restoration site and the reference site in 2008 and 2010. Samples taken from the cores were processed with hydrogen peroxide to remove organic material. The samples were processed through a Coulter Counter Multisizer 3 and using DIFS analysis a grain size spectrum and floc composition was produced for each sample. The shape of the resulting grain size spectrum gives an indication of source material and hydrodynamic processes. Minimal differences were observed in the data collected from the reference marsh and most of the samples processed from the restoration marsh. This indicates a similar source of material and similar hydrodynamic processes were experienced at both reference and part of the restoration site. However approximately half of the samples at the restoration site suggested different processes and source material. DIFS analysis was found to be useful to identify changes in hydrodynamic processes and source material over time.

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DEALING WITH EVERGLADES TRADE-OFFS THROUGH PARTICIPATORY MODELING

Conflicting water needs of South Florida’s urban, agricultural, and natural ecosystem sectors are overly challenging for traditional planning processes. Instead, a mass-balanced spreadsheet model was used to engage stakeholders, allowing them to design hydrological restoration scenarios by manipulating the elements associated with water storage, water treatment, recreation, and agriculture in the headwaters of the Everglades. During 2009 and 2010, fifteen public workshops were organized to deliberately empower participants to interactively design “configurations” that would achieve their objectives as well as restore the Everglades. The government provided model support to the stakeholder teams using RESOPS, a Microsoft® Excel model to simulate managed and unmanaged South Florida surface water hydrology. A one month time step allowed simulations spanning a 41-year weather dataset to complete in <1 sec. This in turn allowed optimization analyses using very large numbers of runs, as well as rapid-response analysis of ideas and configurations proposed by stakeholders. Agricultural stakeholders found that significant land conversions back to wetland were needed to achieve restoration. Environmental groups found that the long-held belief in a “flow-way” did not achieve restoration goals. In the end, the hydrolologic solution was based upon maximizing upstream storage. A similar modeling exercise, needed to find solutions to Everglades water quality and water quantity trade-offs, will be discussed.

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ENVIRONMENTAL CONSTRAINTS ON THE ESTABLISHMENT AND EXPANSION OF A TULE MARSH IN THE SACRAMENTO-SAN JOAQUIN BAY DELTA: PRELIMINARY RESULTS

The Sacramento-San Joaquin Bay Delta in California is recognized for its role in providing important ecological services; however, manipulations to the hydrology and soil through levee construction have resulted in vast loss of wetland habitat. Due to concerns about the Delta’s water quality and ecological function, proposals for controlled breaching of these levees are currently being considered to return the land to a tidal marsh state and reestablish wetland vegetation. This study characterized the effects of edaphic and hydrologic conditions on vegetation at Liberty Island, a post levee-breach restoring marsh. Transplant sites were separated by location to river flow and existing marsh vegetation. We examined the effects of these varying conditions on the establishment and expansion of three species of tidal marsh macrophytes (Schoenoplectus acutus, Schoenoplectus californicus and Typha latifolia). Preliminary results indicate variation in species survival as S. californicus has correlated more successfully than the other two species. Soil bulk density is positively correlated with distance from the existing marsh vegetation. Furthermore, soil bulk density may be influencing interspecies survival as Schoenoplectus species appear more successful in compacted soils than T. latifolia. A series of investigations has been initiated including a seed-bank assay and a manipulative experiment on the effects of soil compaction on macrophyte morphology and physiology. Initial findings of the seed-bank assay indicated higher species richness and abundance in areas adjacent to existing marsh near river flow. This study will improve our understanding of the effects of edaphic and hydrologic conditions on successful restoration of tidal marsh vegetation, thus enhancing the success of future restoration plantings and the evaluations of restoration thresholds regarding proposed post levee-breach wetland restoration.

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DISCOVERY, MAPPING AND CHARACTERIZATION OF SEAGRASS BEDS IN THE TEN THOUSAND ISLANDS, FLORIDA, USA USING MANATEE TELEMETRY, SPATIAL MODELING, AND A CAMERA-BASED SAMPLING SYSTEM

The Ten Thousand Islands (TTI) is recognized as an important region for manatees, fish, sea turtles, and other wildlife that depend on seagrasses, but knowledge of the spatial distribution and characterization of seagrasses is incomplete. There, waters are generally turbid, and attempts to map available seagrass beds from aerial imagery have been largely unsuccessful. We analyzed GPS telemetry records from radio-tagged manatees tracked in the TTI region to delineate possible foraging areas. We then performed stratified field-sampling to correlate the manatee use areas with the occurrence of seagrass or macroalgae during either April (spring) or October (fall). The cells were visually scored using a low-light, high-resolution camera mounted to a rotating frame. The most abundant seagrasses found were Halodule wrightii and Thalassia testudinum. At least one of these species was found in more than 3/4 of the High density cells, more than 2/3 of the Medium density cells, and almost 1/2 of the Low density cells, but generally not in the buffers. Halodule wrightii was found mostly in <1.5m depth at mid tide, and T. testudinum was found in <2.5m depth, but generally >1m depth. Macroalgae was common across all manatee density classes, including the buffers. We also found Halophila engelmannii, Halophila decipiens and Syringodium filiforme in low numbers. There was a strong seasonal component, with all vegetation being more common in the spring than the fall. The results indicate that the manatee locations were a good fit to seagrass beds, supporting the initial assumption that manatee use patterns in shallow water reflects foraging efforts targeted at seagrasses. The sampling techniques presented here can be used as efficient tools for monitoring changes in seagrass beds that may result from Everglades restoration efforts or sea level rise. Where manatee telemetry data exists in other regions, the efficiency of the sampling plan would increase dramatically.

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SEDIMENT AND TOTAL SUSPENDED SOLIDS DATA COLLECTION AND ANALYSIS IN APALACHICOLA BAY, FL

Sediment transport modeling requires knowledge of rivers and wetlands within the domain. To characterize the mechanisms of sediment transport and deposition in coastal regions, data collection and analysis was performed in the Apalachicola River and surrounding wetland
areas in Franklin county, Florida. It is hypothesized that turbulent flow transports well-mixed sediment in the river and the flow becomes laminar upon entering wetlands. This laminar flow allows coarser particles to settle in upstream areas of wetlands, while finer particles remain in suspension and settle downstream. Data collection was conducted over a two-week period during the wet season. Water column samples representative of the particle gradient in the Apalachicola River were used to determine the particle size distribution of the dissolved solids. Sediment samples were collected from surrounding wetlands to illustrate the taper of particle size as wetlands progress toward the ocean. The analysis of sediment particle sizes and their spatial distributions lead to a deeper understanding of the evolution of wetland areas. Future work includes repeating the data collection procedure in the dry season, and again in subsequent years to observe trends. Outputs from a sediment transport model can also be compared to the field data to evaluate the model’s performance and enable more accurate predictions in the future.

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HYDRODYNAMIC SENSORY STRESSORS PRODUCE NONLINEAR PREDATION PATTERNS

Predators often have large effects on community structure, but these effects can be minimized in habitats subjected to intense physical stress. Environmental conditions may not be risky in terms of posing risk of injury or death, but may constrain a predator’s ability to locate prey and allude predators. Pressure may arise from varying environmental conditions, such as velocity, depth, or dissolved oxygen present challenges to ecological analysis. The information quantity in the form of millions of point estimates of environmental parameters contains information that has potential to improve understanding of ecological process. However, extracting useful information from this data is not easy. Numerical models of aquatic environments provide detailed spatial and temporal information about habitats and organisms, and they have been used extensively to study the effects of environmental conditions on populations and communities.

This mixed-method study evaluated changes in a student’s perceptions of science after participating in an after school Project based Learning (PBL) science program. Students completed pre/post tests derived from VNOS form C to evaluate perceptions of science. Multiple choice questions were used to measure the student’s content knowledge. The hypothesis tested the theory whether inquiry based activities of the Science Club changed the students’ perceptions of science when compared to a control group of students who did not participate. Participating students did show changes in their perceptions of science.

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WAVE ATTENUATION OVER INTERTIDAL FLAT ADJACENT TO SALT MARSH

A salt marsh system generally consists of a vegetated marsh, some sort of a cliff edge and an intertidal flat extending into a deeper channel. To understand the role of salt marshes in coastal defense, generally most attention is paid to the dissipative effects of the marsh vegetation itself, or of the evolution of waves over the cliff of the marsh and the erosion of that cliff. Along the river mouth of the Western Scheldt in The Netherlands, the marsh vegetation generally does not endure longer. Yet, stress studies on marshes have been made for more than a century, but the extent that SGD contributed to the high 222Rn activity, a geochemical and geophysical investigation of the IRL area was conducted in June, July and November 2009, and again in July 2010. Surface and groundwaters were collected along a shore-normal transect that extended from Tampa Bay, across the Pinellas County peninsula, to 15 km offshore in the Gulf of Mexico. Surface and groundwaters were collected along a shore-normal transect that extended from Tampa Bay, across the Pinellas County peninsula, to 15 km offshore in the Gulf of Mexico. Samples were analyzed for 222Rn and 220Rn activities, inorganic nutrients, major cations and anions, and dissolved metal concentrations. Cross-shore gradients of 222Rn and 220Rn activities qualitatively indicate a nearshore source for these isotopes, which mix with water characterized by low activities offshore. A cross-shelf mass balance of radon and radium isotopes indicates that SGD rates vary between 6 and 20 cm d⁻¹ proximal to the shoreline and decrease exponentially offshore; integrated total volumetric discharge along the 15-km transect varies between 0.4 and 1.2 m³ d⁻¹ m⁻¹ of shoreline. Implications of SGD as a coastal vector for nitrogen and uranium budgets along this section of the shelf are considered and compared with local riverine inputs.

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INFLUENCES ON RECRUITMENT OF CRASSOSTREA VIRGINICA IN THE INDIAN RIVER LAGOON

The Atlantic Oyster Crassostrea virginica has a wide range throughout the Atlantic and Gulf of Mexico, including the Indian River Lagoon which spans 240 km along the east coast of Florida. The Indian River Lagoon (IRL) C. virginica frequently inhabits red mangrove (Rhizophora mangle) prop roots, though where it recruits and thrives optimally depends on factors that are not fully understood. Previous work in our lab revealed that the distribution of oysters on prop roots was highly patchy, possibly due to limited source populations for larval recruitment or because of variation in physical factors (e.g., freshwater discharges, fetch, sediment type, etc.) or both. One of our primary questions concerns source populations contributing to the local survival of juveniles. We hypothesize that the greatest occurrence of recruitment will occur near inlets (which may receive larvae subsidies from non-IRL populations) and near large stands of R. mangle. To assess the influence of source population on recruitment, we placed 75 15x15 cm plexiglass settling plates on mangrove prop roots at 15 sites distributed semi-randomly over a 100 km stretch of the IRL from Martin to Sabastian counties. This range was ideal because it spans 3 major inlets as well as a broad range of habitat areas. Some sites were near inlets and others were more distant. Others were near large stands of mangroves, and thus presumably a larger pool of potential oysters due to habitat availability, while others were located on isolated mangroves. Recruitment of C. virginica will be assessed each season by counting spat and juvenile abundance on the plates and on adjacent prop roots.

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INTEGRATING BIOLOGICAL DATA WITH HYDRODYNAMIC AND WATER QUALITY INFORMATION FROM NUMERICAL MODELS USING THE EUCLERIAN LAGRANGIAN METHOD (ELAM)

Numerical models of aquatic environments provide detailed spatial and temporal information that has potential to improve understanding of ecological process. However, information quantity in the form of millions of point estimates of environmental parameters such as velocity, depth, or dissolved oxygen present challenges to ecological analysis. The Eulerian Lagrangian Agent Method (ELAM) is one ecological analysis method that...
integrates the vast amount of information contained in numerical models with biological information in an individual based model. The ELAM is also an engineering model that can be calibrated and validated against fish movement or abundance data. Examples of the approach from the Columbia, Sacramento and Mississippi Rivers will highlight incorporation of field data and development of hydrodynamic models under diverse conditions. Modeled fish behavior captures large and small scale behavior for multiple species in comparison to available biological data. The ELAM provides managers with an approach that integrates quantitative information from numerical models and biological field data and allows for analysis of diverse management scenarios. This, in turn, can support refinement of engineering or restoration actions, maximizing effectiveness and reducing cost.

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IMPLANTS OF STORMWATER MANAGEMENT ON WATERSHED-COASTAL ZONE LINKAGES: DETENTION PONDS AS BIOGEOCHEMICAL HOTSPOTS IN COASTAL SOUTH CAROLINA, USA

Stormwater detention ponds are a common means of managing stormwater runoff associated with residential development. These ponds are a particularly prevalent feature of the landscape in the southeast coastal plain due to the region’s flat topography, shallow water table, and storm-driven precipitation patterns. A geospatial inventory of some 14,000 ponds along the coastal zone of South Carolina, USA, reveals that this relatively recent land use accounts for upwards of 5% of the total watershed area in many locations along this coast. Creation of these ponds substantially alters drainage basin hydrology by increasing the volume and area of standing surface waters. The present study explores how this alteration impacts the biogeochemical linkages between watershed and coast as well as the results this has on carbon and nutrient processes in the coastal zone. Thirty ponds, ranging in size from 0.1 to 7.5 ha, were sampled in 2010 and 2011 for ecosystem rates of gross primary production and respiration (determined by diurnal oxygen curves) phytoplankton biomass, and carbon and nutrient concentrations and forms. Rates of net ecosystem production were highly variable among ponds and strongly correlated to total phosphorus concentrations. The bulk of organic carbon production within ponds was as dissolved organic carbon (DOC). While phosphorus appeared to be efficiently recycled within ponds, nitrogen inputs to ponds tended to accumulate as dissolved organic nitrogen (DON). Alteration of coastal hydrology in the southeast due to stormwater management practices, specifically the proliferation of stormwater detention ponds, is thus likely shifting the net metabolic balance of terrestrial surface waters in this coastal zone from net heterotrophy to net autotrophy. In doing so, ponds act as significant sources of labile DOC and DON to coastal marine waters.

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CLONAL ASCIDIANS OVERGROWING INTERTIDAL OYSTER REEFS IN THE INDIAN RIVER LAGOON, FLORIDA

Over the past three years, the abundance of encrusting ascidians has increased dramatically in Mosquito Lagoon, the northernmost region of the Indian River Lagoon system. Abundances have been reduced each year in winter, but return as the waters warm each spring. It is likely that multiple species are present; only Botryllus boharus nigrum has been positively identified through DNA sequencing to date. To understand the role these ascidians play in the ecosystem, we are performing a multi-year study of their biology, ecology, and potential impacts on the benthic community. We have identified 13 species of ascidians, including Botryllus boharus nigrum, that are currently overgrowing oysters in Mosquito Lagoon. Abundance and coverage of ascidians on oyster reefs was assessed by sampling 10 quadrats on each reef in January and July 2011. Of these species, the most abundant was Botryllus boharus nigrum, which accounted for over 95% of the total ascidian cover. This species has the potential to impact the recruitment and survival of oysters and other benthic invertebrates in the area.

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MONITORING THE ECOLOGICAL RESPONSE OF WASTEWATER TREATMENT FACILITY NUTRIENT REDUCTIONS IN NARRAGANSETT BAY, RI

Managers in Rhode Island sought to reduce hypoxia in Narragansett Bay through nutrient reductions in wastewater treatment facility (WWTF) effluent. In summer 2005, the total nitrogen load discharged from WWTFs into the Bay was reduced by 30%. The potential ecological response (reduced organic matter production) of these nutrient reductions was examined in biweekly surveys of production (1 C) and respiration (dark-bottle O2) and continuous monitoring of daily oxygen concentrations during summers 2007-09. An ecological response was not observed: historical (1997-98) production and light attenuation were not significantly different from present. Our survey indicates, however, that when the Bay begins to respond to the reductions, it will not occur linearly as the drivers of hypoxia vary between regions. Hypoxia in 2007-09 was limited to upper stations; lower stations had no hypoxia. Production decreased exponentially south from the Providence River; respiration peaked downstream in the Upper Bay. Hypoxia in the Providence River was driven by stratification, as organic matter was in excess - respiration of 25% of the organic matter produced was sufficient to cause hypoxia under stratified conditions. A very large nutrient reduction would be needed in order to eliminate hypoxia under those conditions. Hypoxia in the well-mixed Upper Bay was caused by elevated respiration, fueled by advection of excess organic matter from the Providence River. A smaller nutrient reduction that may not alleviate hypoxia in the Providence River, could reduce the amount of hypoxia in the Upper Bay. Hypoxia in the well-mixed, low respiration Mid Bay was due to advection of low oxygen water from Greenwich Bay and the Upper Bay. Reductions sufficient to reduce hypoxia in those regions would thus also reduce hypoxia in the Mid Bay. Nutrient reductions necessary to alleviate hypoxia in each region of the bay are currently being quantified with a novel ecosystem model of hypoxia in the Bay.

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AN EVALUATION OF HYPOXIA-INDUCIBLE FACTOR (HIF) AS A BIOMARKER FOR DETECTING LOW OXYGEN EXPOSURE IN AN ESTUARINE FISH

Hypoxia in estuarine systems is a problem of growing concern. In our study system (Lower St. Johns River, Florida), nutrient loading leads to high algal bloom activity and subsequent algal die-off and hypoxia. Many organisms, particularly fish, are highly sensitive to low dissolved oxygen (DO). Under hypoxic conditions a molecule involved in homeostasis, the hypoxia-inducible factor (HIF-1α), is upregulated in fish to help cope with the lack of oxygen, making it an excellent biomarker for detection of hypoxic exposure. This study was designed to determine the correlation between DO and HIF-1α using Spot (Leiostomus xanthurus), a common estuarine fish, to better understand the expression of HIF-1α for the field of biomarker monitoring. Individuals of L. xanthurus were exposed to four treatments (7.5, 5.0, 3.0, and 2.0 mg/L DO) and sampled at intervals of 0, 1.5, and 3 days to determine the expression HIF-1α depending on both concentration and duration of DO. Significant correlations were found between both concentration and duration of hypoxia, as well as a significant interactive effect under hypoxic conditions. The results of this study could help suggest that findings of elevated HIF-1α in fish from the field would suggest recent hypoxic or hypoxia-like stress.

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ASSESSING THE INVASIVE POTENTIAL OF EXOTIC MANGROVE SPECIES IN FLORIDA USING CLIMATE ENVELOP MODELS WITH DOWN SCALABLE AOGCM CLIMATE PREDICTIONS

Thirteen species of exotic mangrove species have been introduced in south Florida over the past 60 yrs. Of these, six are alive and actively producing viable propagules, and one has been declared invasive by the Florida Council on Exotic Plants. Previous research indicates that several of these exotics can compete quite successfully with Florida’s three native mangroves. We assessed the potential invasiveness and spread of these species with a scenario of future climate based on the down scaling of general circulation model output to regional scales. The future climate scenario was one of a hotter and dryer southeast United States in June, July and August. The down scaled climate outputs were used as inputs for climate envelope models developed for each species. Observations of the effects of extreme events (two freezes) on the extant populations were also made. Results indicate that all of the exotic mangroves have traits which could lead to invasiveness and spread in south Florida. Range expansion northward along both Florida coastlines also is possible. This is due to the dispersal capabilities of the propagules and abundant availability of suitable substrate, coastal marshes, for establishment. Northward spread will also depend on changing frequencies of extreme events and individual species responses. Observations after the
Nutrient loading to estuaries has led to increased instances of eutrophication and reduction in species diversity. The microbial community in the sediments associated with oyster reefs can contribute to oyster reef enhancement of sediment denitrification. The microbial community includes various bacteria and archaea that play a role in the process of nitrogen cycling. These bacteria and archaea are capable of converting ammonium to nitric oxide, which can then be converted to dinitrogen gas through a process known as denitrification. This process helps to remove excess nitrogen from the water column and reduces the risk of eutrophication.

The microbial community associated with oyster reefs can also contribute to the accumulation of benthic diatom communities. Diatoms are a group of microorganisms that play a crucial role in the marine food web. They are often referred to as the “grazers” of the ocean because they feed on other microorganisms and contribute to the overall productivity of the ecosystem. The accumulation of diatoms on the oyster reefs can help to sequester carbon and nitrogen, which can reduce the risk of eutrophication and improve water quality.

In addition to these ecological benefits, oyster reefs can also provide economic benefits to local communities. Oysters are a valuable resource for human populations, providing a source of food and income for many coastal communities. The development of oyster reefs can also provide opportunities for tourism and recreation, which can further contribute to the economic well-being of local communities.

Despite these benefits, the development of oyster reefs can also present economic challenges. The initial cost of establishing oyster reefs can be significant, and there are also ongoing costs associated with maintaining the reefs. However, the long-term benefits of oyster reefs can outweigh these costs, making them a valuable investment for coastal communities.

In conclusion, the development of oyster reefs can provide ecological and economic benefits to coastal communities. These benefits include improved water quality and biodiversity, as well as economic opportunities for local populations. However, it is important to consider the economic challenges associated with the development of oyster reefs, and to develop strategies that can address these challenges and maximize the benefits of oyster reefs.
Following biological invasions by aquarium strains of the green macroalga Chaetomorpha, and current wetland condition suggest that the causes of salt marsh loss and invasion threat to estuarine and coastal ecosystems. We tested five common techniques for killing aquarium plants for their effectiveness at a variety of exposure times, on both small clumps (0.01 to 1 gram) and 1 cm fragments of Chaetomorpha. Techniques included: microwaving, freshwater, boiling, freezing, and desiccation. Three iterations of each experiment were done with different samples of Chaetomorpha purchased online and via e-commerce. Samples were monitored for mortality at repeated intervals for two days following exposure. Four methods: microwaving, freshwater, boiling, and freezing were effective at test exposure, while desiccation may require longer than tested durations to be effective. Microwaving and boiling were the most efficient methods with 100% effectiveness at 15 and 60 seconds, respectively. Freezing and freshwater were effective at exposure periods of 2 and 6 days, respectively. Desiccation may be an effective method at exposure periods longer than 4 hours. All methods were equally effective for the fragments and small clumps. The results obtained from these experiments will be utilized in outreach materials to aquarium hobbyists and professionals in our efforts to prevent future detrimental seaweed invasions associated with aquarium release.

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**PREVENTING INTRODUCTION: OUTLINING SAFE METHODS FOR KILLING AQUARIUM CHAETOMORPHA PRIOR TO DISPOSAL**

Coastal wetlands are a hallmark feature of the Delaware Estuary where they form a nearly continuous fringe and furnish many important ecosystem and human services. These coastal wetlands have long been maligned where nearly half have been lost, degraded or otherwise altered. According to the USFWS and NOAA, the loss of these habitats continues with approximately 3,000 hectares lost between 1986 and 2006. Remote sensing data suggests that the majority of our remaining 150,000 hectares of tidal wetlands are also degraded in condition, likely a precursor for more losses to come. Past and present land use practices appear to be contributing to the decline of coastal wetlands in the estuary. We contrasted current salt marsh condition with past changes in their configuration and extent in the Delaware Estuary to better understand how various land use stressors may have impacted these valuable habitats. Salt marsh current condition and past configuration was examined in three representative freshwater bodies: the St. Jones River watershed, DE; the Broadkill River watershed, DE; and the Maurice River watershed, NJ. Salt marsh condition was determined during 2010-2011 using rapid assessment methods at 30 randomly selected sites per watershed. Monitoring changes in salt marsh configuration and land cover were characterized with various spatial and temporal analysis tools and metrics assessed from a time series of aerial photographs at the same 30 sites. Comparative analyses of past practices, wetland configuration, and current wetland condition suggest that the causes of salt marsh loss and degradation are complex and site-specific.

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**RADIOIODINE AS A PARTICLE TRACER IN THE UPPER DELAWARE ESTUARY**

Radioiodine (I-131) discharged in wastewater effluent to the Delaware River provides a novel tracer of suspended particle routing through the river-estuarine system. A medically used radionuclide, I-131 passes through the municipal waste stream and upon reaching aquatic waters adsorbs to suspended particles. With known inputs and an 8-day half-life, I-131 has proven to be an effective short-term, source-specific tracer of suspended matter in a wide range of urban rivers and estuaries. Water and bed samples collected along the axis of the tidal Delaware River and estuary during 2010-2011 revealed that I-131 is cycled between the water column and bed sediments on time scales of days. The distribution of I-131 measured during repeat surveys indicates that a large fraction of sediment supplied from the watershed is stored within the tidal river and upper estuary before being dispersed seaward to the turbidity maximum zone. Use of I-131 along with Be-7 and Pb-210 as a tracer of particle sources and residence time in the Delaware Estuary will be discussed.

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**ANAMMOX AND DENITRIFICATION IN THE CAPE FEAR RIVER ESTUARY, NORTH CAROLINA**

An aerobic ammonium oxidation (anammox) and denitrification are two main microbial processes capable of removing fixed nitrogen by conversion into a gaseous species. Both microbial processes are known to occur in anoxic sediments of estuaries, yet little is known about the spatial and temporal variations of their rates along the estuarine gradients. In order to estimate an estuarine N removal capacity mediated by anammox and denitrification, we conducted two seasonal samplings to collect sediments across transects at fifteen stations along the Cape Fear River Estuary, which is heavily impacted by anthropogenic nitrogen loadings. 131I Tracer incubation experiments with sediment slurries were conducted to measure the rates of anammox and denitrification. Quantitative PCR of hydrazine oxidase (bas) and nitrous oxide reductase (nosZ) genes was conducted to estimate the abundance of anammox and denitrifying bacteria in sediments, respectively. Denitrification was found to be the dominant process in all samples analyzed, with anammox accounting up to 19% of total N production. Denitrification rates ranged from 0.08 to 16.62 mmol N g-1 h-1 while anammox rates were 0.00 to 1.65 mmol N g-1 h-1. Mean potential N production rate was estimated to be 1.57 mmol N m-2 d-1. Multivariable analysis showed that anammox was positively correlated with ammonium levels while denitrification had strong correlation with the organic content of sediments. Quantitative PCR of hzo genes estimated the abundance of anammox bacteria to be 3.9x109 to 7.0x109 cells per g sediment while denitrifiers ranged from 8.0x109 to 1.5x1010 cells per g sediment. Linear correlations between the abundances and activity rates of anammox and denitrifying bacteria were observed. Thus, this study demonstrated the use of hzo and nosZ gene abundances as proxies for the rates of anammox and denitrification as well as refined potential N2 production capacity in the Cape Fear River Estuary.

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**INCORPORATING NOVEL GENETIC AND MOLECULAR ANALYSIS INTO SPARTINA SPP., INTEGRATED WEED ERADICATION MANAGEMENT**

Spartina anglica and spp., are invasive, perennial marsh grasses that are capable of transforming the intertidal zone. These cord grasses are ecosystem engineers that directly threaten the ecosystem services provided by the intertidal zone and the biodiversity richness of this habitat. The intertidal zone is considered critical habitat and has important roles related to over hundreds of associated species from all phyla. As implications of direct and indirect effects of Spartina spp. hybrids become more apparent, so is the need for a collaborative agreement between policy, management, and science that focuses on the best management approaches and integrated weed management (IWM) plans currently available. Literature surveys reveal that Spartina spp. invasions, and seagrass conservation needs, are global-scale problems that urgently require novel management approaches. Improving management approaches toward invasive cord grass eradication is to incorporate the understanding of weedy traits, rapid evolution, and preservation of habitat requires knowing how stakeholders approach conservation, sustainability, and resource consumption values. Novel genetic and molecular data analysis approaches can be used to aid stakeholder management decisions. Bioinformatics and phylogenetic analysis are emerging fields that combine molecular and evolutionary biology, computer sciences, mathematics and statistics, and a vast quantity of readily accessible unanalyzed data. From these datasets, inferences
about the interplay of ecological, molecular, genetic, and evolutionary dynamics that facilitate rapid evolution of weedy traits can be explored with mathematical models. Therefore these novel genetic and molecular data analysis approaches can be applied to solve biological and ecological questions of invasive cord grass rapid evolution and be incorporated in to Spartina Eradication program management plans.

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MONITORING TURBIDITY MAXIMUM IN THE UPPER REACHES OF THE GIRONDE MACROTIDAL ESTUARY (FRANCE): IMPLICATIONS FOR ESTUARINE ECOLOGY

The Gironde estuary is the largest estuary of the Atlantic coast of Europe, with a well developed turbidity maximum characterized by high suspended sediment concentrations (SSC), over 1 g.l-1. It has been proven for years that this high turbidity zone plays a key role on sedimentation processes but also on biochemical processes that control environmental water quality. Therefore, and especially in a context of climate change, understanding and predicting trends of turbidity is crucial for better predicting the future evolution of the estuary and its associated ecosystem. The objective if this study is to progress in the understanding of dynamics of turbidity a seasonal basis in the Gironde estuary. This study takes advantage from the MAGEST program database. The MAGEST network consists of four stations situated along the Gironde fluvio-estuarine system. One of them is located at Pauillac, at 50 km upstream from the mouth. Two of them are situated in the Garonne river (Bordeaux and Portets), at 50 km and 70 km upstream from Pauillac respectively. Each station provides continuous measurements of salinity, temperature, dissolved oxygen and SSC, at 1m below the free surface, with a time step of 10 min. The network started to work in 2005, so a 5-year record is now available. At seasonal timescales, there is a good correlation between the estimated sediment mass in the turbidity maximum and the river flow. An empirical relationship is achieved between SSC at Bordeaux and the averaged river flow. In the meantime, SSC in Pauillac Station are less sensitive to changes in river flow, confirming that in secondary turbidity maximum spread in the middle estuary, as suggested by previous. Finally, high turbidity in summer is correlated with periods of decrease of dissolved oxygen in riverine waters at Bordeaux. Causes and consequences for biology are highlighted and discussed.

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EFFECTS OF SHORELINE HARDENING ON THE RECRUITMENT OF JELLYFISH, CHRYSOA RO QUINCECIRRHA, POLYPS IN THE CHESAPEAKE BAY

The scyphomedusan jellyfish, Chrysaora quinquecirrha (the sea nettle), is an important consumer in the Chesapeake Bay food web. A key requirement for sea nettle polyp recruitment onto oyster shell and materials used for shoreline hardening (rock, wood and steel). Recruitment was similar on oyster shell and rock, and was substantially higher on those substrates than on wood or steel. Recruitment was also higher on substrates placed close together (mimicking crevices) than on more exposed surfaces. To address the complex three dimensional nature of rip-rap reinforced shorelines, we conducted a series of experiments in 2011 to compare polyp recruitment at different tidal heights and substrate orientations. Our results do indicate that the use of rock to reduce shoreline erosion may increase the recruitment of sea nettle polyps, thereby potentially influencing medusa abundances and distributions and altering Chesapeake Bay food web dynamics.

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SEDIMENT AND SUNLIGHT: NUTRIENT AND DISSOLVED ORGANIC MATTER RELEASE FROM SEDIMENTARY ORGANIC MATTER PHOTOLYSIS

Shallow coastal sediments are frequently resuspended due to a combination of natural and anthropogenic forces (e.g., dredging, storms). Sediment resuspension is well known to increase nutrient and dissolved organic matter (DOM) concentrations due to porewater dispersal and desorption from particles. However, it has recently been shown that resuspended sediments exposed to sunlight in surface waters also undergo photolysis, resulting in significant release of dissolved organic carbon (DOC), dissolved organic nitrogen (DON), NH4+, and PO43-. We will present results from a series of laboratory experiments designed to investigate the environmental and organic matter source controls on sediment photolysis using a combination of photolytic flux measurements coupled with biogeochemical and molecular characterization of sedimentary organic matter (SOM). Preliminary results suggest that SOM source and diagenetic state significantly influence both the magnitude and composition of the photochemical release from resuspended sediments. Furthermore, our results demonstrate that the amount of DOC released per gram of fine (≤10-20 um) sediment is 10 times higher than the amount measured in previous studies which employed bulk sediments. Because fine sediments stay in suspension longer, this higher value is likely more representative of fluxes in situ. These data suggest that a portion of the observed water quality changes after resuspension events may be due to photolysis of SOM. Such events could increase in frequency or intensity if continued land development exacerbates sediment mobilization, ultraviolet light levels increase, or if coastal storms become more frequent or energetic due to climate change. Photochemical processes could thus be an episodic yet potentially important influence on water column nutrient and DOM concentrations, as well as nutrient element stoichiometry, compounding other perturbations associated with sediment resuspension.

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TIDAL ADVECTION-DIFFUSION AS A TRANSPORT MECHANISM FOR BIOGEOCHEMICAL PROCESSES IN A SEMI-ARID LAGOON

Advection-diffusion as a transport mechanism for biogeochemical processes in a semi-arid lagoon. Semi-arid lagoons characterise by the lack of freshwater inputs so that any new nutrients, carbon and other biogeochemical material should be imported into the lagoon from the adjacent coastal ocean. The Pacific Coast of Baja California characterises for strong upwelling which brings nutrients from deep waters into the coastal ocean. So it is expected that the overall nutrient flux into the la goon will be modulated by the frequency of the upwelling pulses. The main question is: how do the nutrients get transported from the coastal ocean into the lagoon. We suggest that the upwelled nutrient rich waters from the adjacent coastal ocean are brought into the lagoon through tidal advection-diffusion processes. This hypothesis is tested using a 1-D coupled physical-ecological model (ERSEM-GOTM) in which we allow observed horizontal gradients to be advected and diffused using the horizontal density velocities and mixing from the 1-d model. The model is compared with data (i.e. current velocity, temperature, chlorophyll a and nitrate concentration) collected during May-July 2005 at the mouth of San Quintin Bay, Baja California, Mexico.

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EFFECTS OF DENSITY GRADIENTS AND FRESHWATER RIVER INPUT ON SEDIMENT TRANSPORT IN ESTUARIES

In this work we study the effects of density gradients and freshwater river input in estuarine sediment transport and morphodynamics. We investigate these effects using POLCOMS a 3-dimensional baroclinic model coupled with an Eulerian sediment transport model. The Eulerian model was set up for a simple idealised estuary, 100 km long, 3km wide and 15m deep semi-enclosed basin, forced at with a tidal elevation amplitude of 1.3 m and a barotropic tidal current of 1.5 m/s with a D50 of 0.040mm and a settling velocity of about 1
mm-s^{-1}. To study the baroclinic effects from the density gradients and river freshwater flow the model was run in different scenarios: barotropic, with and without river flow; and 3D baroclinic cases, with different river flows (including no flow) and imposed salinity difference between the head of the estuary and the mouth of 30 psu or 15 psu. Density gradients modified the flow, by creating extra residual currents, either being, density driven or due to effects of tidal straining; not only this but they have also the capability of modifying the tidal currents and the diffusivity. The interaction of these modified flows with suspended sediment, produce a very different transport than if we do not them. This is an interesting result as many of the engineering models used in estuaries tend to be used in barotropic mode to predict sediment transport and morphodynamics, which does not allow baroclinic effects due to density gradients and stratification.

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NUTRIENT FILTRATION EFFECTIVENESS OF TWO SALT MARSH RESTORATION DESIGNS

The most valuable ecosystem service provided by salt marshes is the filtration and removal of nutrients prior to entering coastal waterways. Relatively few studies have evaluated the magnitude of nutrient filtration provided by Juncus roemerianus dominated salt marsh communities and even fewer studies have been conducted on restored J. roemerianus. In this study we used two J. roemerianus restoration designs of varying costs and effort, a half-density (least costly) and a full-density (most costly) treatments. Treatments were evaluated for nutrient filtration capabilities of an isotopically enriched 15N NO3 solution, loaded at 7.68 mmol s m^{-2} d^{-1}, which also contained a conservative tracer (Br^-). The solution was pumped continuously for 31 days and porewater samples were taken at 3 locations within each plot on 8 sampling days. Concentrations of DIN were higher in the control (unvegetated) treatment than the vegetated treatments. The ratio of DIN to Br^- indicated the vegetated plots removed significantly larger amounts of DIN from the introduced solution than the unvegetated plots (p < 0.008). Controls, half- and full-density treatments removed 31.5 ± 10.6%, 77.1 ± 10.1% and 89.2 ± 3.3% of the DIN in the introduced solution respectively. Isotopic analysis of J. roemerianus in the vegetated plots revealed half-density vegetation assimilated 5.3 ± 0.6% of the introduced DIN whereas full-density vegetation assimilated 2.6 ± 0.2%. Introduced DIN stored in bulk sediments only accounted for <1% of the introduced amount and did not differ among treatments (p = 0.346); leaving bacterial removal responsible for the remaining >30.5%, >70.8% and >85.6% removed in control, half- and full-density treatments respectively. These results suggest that the presence of restored J. roemerianus can substantially enhance the removal of nutrient pollution from a groundwater plume and the less costly half-density planting design may be more cost-effective.

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COMMUNITY METABOLISM IN CHESAPEAKE BAY: HISTORICAL AND CONTEMPORARY MEASUREMENTS

Data generated from Maryland DNR Continuous Monitoring (ConMon) stations located throughout Chesapeake Bay is amenable to calculating community metabolism rates because it is collected at high frequency intervals (15 minutes; April – October). In addition to ConMon data, we found and developed a rare high frequency data set spanning the period 1964-1969, a time prior to serious eutrophication of Chesapeake Bay. An algorithm was developed to allow rapid computation of community primary production and respiration. Results from the algorithm show that metabolism rates from the mid 1960s were lower than all contemporary sites and much lower than those in nutrient enriched sites. The seasonal pattern has also changed. Primary production in the 1960s peaked early in the year (May-June) and now peaks during July-September. In preliminary work we have found strong relationships between nitrogen loads and community metabolism with no indication of “nutrient memory” at most locations. Community metabolism may prove to be a useful metric for evaluating the success of the Chesapeake Bay Program in reducing nutrient loads to this system and improving water and habitat quality.

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TRACKING THE DISTRIBUTION OF NON-NATIVE MARINE SPECIES, M. CHARRUANA, P. VIRIDIS, AND MEGABALANUS COCCOPOMA, ALONG THE SOUTHEASTERN UNITED STATES COASTLINE

Non-native species often possess the capacity to become invasive, causing adverse effects on the environments they colonize. Invasive species compete with native species for resources including food and living space. When non-native species become prevalent, they can drive indigenous species to local extinction and alter the natural ecology of the area. Tracking non-native species is crucial for understanding their population growth and distribution. Three non-native marine species have recently colonized the Florida coastline: Mytila charruana, the charru mussel; Perna viridis, the Asian green mussel; and Megabalanus coccopoma, the titan acorn barnacle. Mytila charruana was discovered in the Indian River Lagoon, FL in 2004. Perna viridis was found in Tampa Bay, FL in 1989, and in 2002 it was discovered in Ponce de Leon Inlet. Megabalanus coccopoma was first documented in St. Augustine, FL in 2006. Beginning in 2006, a bimannual survey of the southeastern coastline has been conducted from Jupiter, Florida to Charleston, South Carolina to track the distribution and range expansion of M. charruana, P. viridis, and M. coccopoma. Currently, 82 sites (e.g. docks, boat ramps, jetties, mangrove roots) are monitored each June and December. Each site is searched for at least 20 minutes, and all target species are measured and collected. The ranges of the three species have expanded and retracted along the Atlantic coast since the survey began. Mytila charruana spread into Georgia and South Carolina in 2007, but the species has recently been absent from South Carolina and northern Georgia. Mytila charruana and Megabalanus coccopoma were present in Georgia in 2007, but both were absent in the 2010 survey. These range fluctuations could be explained by recent extreme cold temperatures, which occurred during the 2009/2010 and 2010/2011 winter seasons. The patterns observed may lead to general conclusions regarding how non-native species spread to and colonize new environments.

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ESTIMATION OF FRESHWATER INFLOW REQUIREMENTS FOR A SEMI-ARID SALT MARSH USING EMERGENT PLANTS AS INDICATORS OF ECOSYSTEM CONDITION

Emergent plant community dynamics in salt marshes are driven by the underlying physiochemical properties of their environment. A prominent feature of these systems in South Texas is the occurrence of seasonal freshwater inflow events as a result of tropical storm fronts. This study examines the impact of these events on environmental gradients within the Nueces Delta, TX based on long term monitoring data. One of the most conspicuous changes in the emergent plant community has been the near complete loss of cordgrass (Spartina alterniflora) and its subsequent recolonization in low marsh areas. We examined the relationship between cover of S. alterniflora and cover of its primary competitor Borrichia frutescens with respect to porewater salinity and freshwater inflow. Porewater salinity, which fluctuated between 0% and 80%, was negatively correlated with freshwater inflow. Periods of low freshwater input and high porewater salinities (40%) were characterized by dramatic declines in the abundance of S. alterniflora while the development of fully hypersaline conditions (60%) resulted in the loss of the more salt tolerant species B. frutescens. Patterns of plant cover and community composition reflect the prevailing environmental conditions in the Nueces Delta and are proposed as indicators of ecosystem function. The necessary freshwater inflow required for maintaining optimal environmental conditions in this system are flagged by the apparent physiological thresholds of B. frutescens and S. alterniflora.

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MUSSEL FARMING QUESTIONED AS A MITIGATION MEASURE OF EUTROPHICATION IN THE ATLANTIC SEA

During recent years mussel farming has been suggested as a measure to mitigate eutrophication in the Baltic Sea. Harvest of mussels that have retrieved nutrients is accounted for. However, the impact of the mussel farms on the sediment processes underneath the farms have not been taken into consideration. Studies from around the world show that the regeneration of nutrients and the outflow of ammonium and phosphate from the sediment into the water column are in the same orders of magnitude as the amount of
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nutrients harvested. Therefore we question mussel farming as a way to reduce the nutrient content in the Baltic Sea.

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ARCTIC FISH COMMUNITY RESPONDS TO WARMING OF GREENLAND WATERS

The continental shelf around Greenland range from sub-Arctic conditions in southern Greenland to Arctic conditions at northerly latitudes with a seasonal ice cover exceeding 9 months. The approximate south to north orientation of the coast line creates a gradient in climate that is very useful for studying effects of ocean temperature and sea ice cover on distribution and abundance of marine species along the latitudinal gradient. In this study, we investigate changes in the Greenland fish fauna. Because of its commercial importance the fish fauna is among the best studied ecosystem component in Greenland and annual surveys has been conducted since 1988. Based on two decades of survey data covering the east and west coast of Greenland we characterize the oceanographic conditions and link the distribution of individual fish species as well as species assemblies to changes in environmental variables along the north-south latitudinal gradient. We explore whether the recent warming in the Arctic has led to changes in species size, composition and distributional limits of fish species in the Greenland coastal waters. Our analysis focus on 18 commercially important fish species, which constitute 66% of the total fish catch during the survey period. Preference temperature regimes, depth zones and geographical distributions are identified for individual species and used in combination with climate scenarios of changes in oceanographic conditions to evaluate future distribution ranges.

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HYDROLOGIC DYNAMICS OF A SUBTROPICAL ESTUARY, USING GEOCHEMICAL TRACERS, CELESTIHN, YUCATAN, MEXICO

Celestún Lagoon is a small subtropical estuary in the Yucatán peninsula of Mexico and is underlain by karstified limestone with numerous locations where groundwater can be seen discharging directly into the surface water. In this study samples of groundwater and lagoon surface water and seawater were collected in April, 2008 and June, 2009 and analyzed for salinity, stable isotopes of oxygen, and Sr²⁺ concentrations. These geochemical tracers were used in two tertiary matrix mixing models to calculate the relative ratio inputs of fresh groundwater, brackish groundwater, and seawater. Fresh groundwater had a oxygen isotopic signature and strontium concentrations of δ18O = -3.30 ‰, Sr²⁺ = 0.03 mM, while brackish creek water from the east end of the bay has a dissimilar oxygen isotopic signature and Sr²⁺ concentration of δ18O = 3.01 ‰, Sr²⁺ = 0.12 mM. Local seawater has an isotopic signature and Sr²⁺ concentration in between the two fresher sources (δ18O = -1.40 ‰, Sr²⁺ = 0.09 mM). The lagoon wide results of the two tracer mixing models (180 and Sr²⁺) agreed in their respective signature and Sr²⁺ concentration in between the two fresher sources (

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APRIL IN PHOTIC AREA WITH CLIMATIC CHANGES IN A SHALLOW ESTUARY

In shallow estuaries, such as the New River Estuary (NRE), NC, benthic microalgal (BMA) production plays an important role in modulating nutrient enrichment by removing nutrients from the water column or sediment. Multiple water quality factors, including chlorophyll dissolved organic matter (CDOM), chlorophyll a, and turbidity, can reduce the quantity of light that reaches the bottom of the estuary, which in turn controls the rate of BMA production. Dataflow surface water quality mapping surveys were conducted along the shallow shoreline of the NRE seasonally from 2008 to 2010, which provided high-spatial frequency (approx. every 30 m) water quality measurements and GPS locations. Based on a significant multiple regression relationship between light attenuation (Kd) and CDOM, chlorophyll a, and turbidity measured in the NRE during multiple experiments, K values were predicted for the Dataflow cruises and then interpolated for the entire estuary with ArcGIS. Using the interpolated Kd values and the NRE bathymetry, the percentages (%) of bottom area in the NRE receiving at least 1% to 20% of surface irradiance were estimated. In a few cases, changes in light availability could be attributed to local disturbances, however in general across the estuary, water quality and Kd were affected by changes in seasonal and climatic factors, which in turn control freshwater discharge. The 5% of photic area necessary to support BMA production (defined as receiving at least 1% surface irradiance) showed a significant negative relationship with freshwater discharge, explaining 44% of the variation in photic area. Multiple regression analysis further showed that daily low air temperature and wind direction were significantly related to photic area, together explaining 85% of the variability. As a result of seasonal and climatic changes, the photic area varied from 46-97% of the total estuarine area from 2008 to 2010.

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THE URGE TO MERGE: DATA INTEGRATION OVER DIFFERING SPATIAL AND TEMPORAL SCALES

Dissolved oxygen concentrations of less than 3 mg/L have consistently been measured over the past several years during late summer and fall in Quartermaster Harbor, a shallow coastal embayment between Vashon and Marrow Islands in Puget Sound, Washington. These low dissolved oxygen values, coupled with large phytoplankton blooms throughout most of the
year, prompted King County to lead a multi-agency, four-year nutrient management study. This study, funded primarily by an EPA West Coast Estuaries Initiative grant, began in 2009. The study objective is to evaluate the role nitrate inputs to dissolved oxygen dynamics in Quatmeter Harbor. Physical, chemical, and biological data collected on differing time scales (ranging from 15-minute intervals to monthly) and by multiple techniques (CTD profiles, discrete water samples, in-situ automated systems) are being integrated to provide insight into nutrient and oxygen dynamics in the harbor. Monthly CTD and discrete water sample data indicate the amount of variability within the water column, whereas the in-situ data show the amount of diurnal and day-to-day variability. Monthly to bi-monthly phytoplankton community data are being evaluated together with the CTD and in-situ fluorescence (surrogate measure of phytoplankton biomass) data to provide a more comprehensive picture of productivity dynamics. Data collection is an important project component. The data, along with a hydrodynamic and water quality model of the harbor (currently under development), will support updated nutrient management recommendations for King County’s 2012 Comprehensive Plan. Details regarding the various data collected will be presented, along with how the data are being integrated to provide an overall assessment of nutrient and oxygen dynamics in the harbor. Selected results will also be presented.

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SUCCESS OF A SPARTINA ALTERNIFLORA MARSH IN A LARGE-SCALE CHESAPEAKE BAY RESTORATION PROJECT

As part of the Poplar Island Environmental Restoration Project there is a plan to create approximately 298 hectares of tidal marsh habitat, primarily using material dredged from shipping channels in the upper Chesapeake Bay. Unlike the sandy material used in many coastal marsh restoration projects, this material is fine-grained and nutrient rich. The first wetland cell completed was constructed using locally obtained sand while subsequent cells were constructed with the upper Bay dredged material, providing an on-site comparison. Striking differences in the vegetation quickly developed on the two substrates, including sparser vegetation and higher recruitment of new species on sand, and lodging, intense muskrat grazing and high rates of fungal infection on dredged material. Biomass production was much higher (up to 3 kg m⁻²) and root:shoot ratios were much lower (as low as 0.1) on dredged material, and die-back was common on dredged material but not on sand. We hypothesize that the observed differences are due to the nutrient content of the substrates and possibly to subsidence in the dredged material cells due to compaction. Since external inorganic sediment inputs will be limited in this system due to the limited drainage area, belowground biomass production is especially important for vertical accretion, which is necessary to keep abreast of local sea-level rise (SLR), currently 3.2 mm yr⁻¹ in Chesapeake Bay and expected to at least double over the next century. Given the goal of creating self-sustaining marshes, healthy, productive marshes that contribute sediment accretion are essential to the long term success of the project. Thus far accretion rates have not been keeping up with SLR, but as habitat the marsh is attracting a wide variety of wildlife.

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ECOSYSTEM UNDER PRESSURE: DEFINING THE DINOFLAGELLATE COMMUNITY IN GALVESTON BAY, TEXAS (USA)

The occurrence of coastal harmful algal blooms (HABs) appears to be rising globally, in both temporal and spatial extent, over the last few decades. Within Galveston Bay (Texas), HABs have had a large fish kill and shut down of the productive oyster hatcheries on multiple occasions. The culprits in these incidents are often identified as dinoflagellates, most recently Akashiwo sanguinea and Dinophysis sp. A high volume of foreign vessel traffic through the Houston Ship channel, traversing Galveston Bay, escalates the rate of invasion by a non-indigenous species. In 2010, over 7,800 ballast water reports were submitted from vessels entering Galveston Bay, up 5% from 2009. The number of vessels is set to increase with growing global commerce and port expansions in this area. In order to address these concerns, we examined the dinoflagellate communities in Galveston Bay, including the Port of Houston and the Port of Galveston, between May 2005 and June 2009 using traditional microscopic methods as well as modern molecular methods. By targeting 185 rDNA from environmental samples, dinoflagellates were identified by sequencing the end product after DGGE analysis. Microscopy was conducted to verify the molecular results. We identified at least 15 dinoflagellate genera common to Galveston Bay. Of these, at least half are known to contain toxic species, stressing the importance of continued monitoring within this region. Increasing propulsive pressure enhances the economic and environmental vulnerability of this region to bioinvasion, emphasizing the need to determine if harmful algal species are being delivered to these ports via ballast water. Future efforts will therefore involve determining the dinoflagellate community composition in ballast water of ships entering the ports in Galveston Bay.

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FISH ASSEMBLAGES IN THE OLIGOHALINE ZONE OF A SOUTHWEST FLORIDA RIVER DURING PERIODS OF EXTREME FRESHWATER INFLOW VARIATION

Maintenance or restoration of the oligohaline zones (i.e., salinity 0.5-5) of coastal rivers is increasingly becoming an important goal of water managers striving to balance human consumption of water with the ecological integrity of estuaries. The objectives of this study were to compare fish assemblage structure and species-specific abundances of the oligohaline zone to those of the lower river mouth in a southwest Florida river (i.e., Peace River) during periods of varying freshwater inflow. The abundances of several estuarine and coastal-shelf transient taxa captured by 21.3 m seine—sand seastart Cyamus arenarius, tidewater mosquito Eucinostomus harngus, red drum Sciaenops ocellatus, and spot Leiostomus xanthurus—were similar between river sections, which is consistent with the premise that the oligohaline zone is an extension of the juvenile habitat known to be important for transient fish in lower rivers. Estuary residents—such as mosquitofish Gambusia holbrooki, rainwater killifish Lucania parva, and salinol molly Poecilia latipinna—were at least an order of magnitude more abundant in the oligohaline zone, likely the result of higher production at low salinity, greater marsh area, or less competition. The abundance of piscivorous fishes captured by 61-m seines in the oligohaline zone—such as S. ocellatus, common snook Centropomus undecimalis, ladyfish Elops saurus, gray snapper Lutjanus griseus, and Florida gar Lepisosteus platyrhincus—was similar to that of shorelines in the upper estuary, and half that of shorelines in the lower estuary. During a severe drought, the oligohaline fish assemblages became more similar to assemblages of the lower river mouth, and the abundances of the species that define the oligohaline zone were reduced. This study demonstrates that dramatic changes in the position of the freshwater-saline interface can lead to measurable biological changes.

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SPATIAL MODELING OF RELATIVE ELEVATION AND SOIL ORGANIC CARBON STORAGE IN COASTAL LOUISIANA

Coastal wetlands as a whole are net sinks for greenhouse gases and sequester a significant amount of carbon within soils. Although global sea level rise (SLR) is approximately 3.1 mm yr⁻¹, a much higher land subsidence rate (as high as 35 mm yr⁻¹ in Mississippi Delta Plain) is estimated for coastal Louisiana. Therefore, the benefit of future wetland restoration projects should be evaluated based on predicted landscape response to the combination of rising sea level and high subsidence. A pre-compaction relative elevation model was used to predict changes in coastal-wide vertical accretion and elevation from 2010-2060 under varying scenarios of accelerated SLR, subsidence and restoration projects. Vertical accretion and organic matter accumulation rates were calculated from simulated annual rates of mineral sedimentation, and site-specific soil bulk density and percent organic matter sediment core data. Mineral sediment accumulation was derived from coast-wide settlement-based hydrodynamic model and then spatially redistributed using a weight surface. Bulk density and percent organic matter among hydrologic basins and vegetation types were calibrated using soil core data from Louisiana's Coastwide Reference Monitoring System (CRMS). Using this empirical relative elevation model, coast-wide soil organic carbon stocks were assessed under these natural and anthropogenic factors. Spatial modeling results indicated a substantial portion of the Mississippi River Delta wetlands, under future without

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project scenarios would be submerged in the next half-century under high SLR and subsidence rates. As a consequence, carbon storage capacity of the delta wetlands was significantly diminished. The magnitude of carbon lost will depend upon the area of wetland loss and the locations of that loss within hydrologic basins and vegetation types. Significant restoration project investments are needed to reduce soil elevation and associated carbon loss.

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RAPID SEAWATER CIRCULATION THROUGH ANIMAL BURROWS IN MANGROVE FORESTS - A SIGNIFICANT SOURCE OF SALINE GROUNDWATER TO THE TROPICAL COASTAL OCEAN

A common approach for quantifying rates of submarine groundwater discharge (SGD) to the coastal ocean is to use geochemical tracers such as Re-222 and short lived radium isotopes, which are naturally enriched in groundwater relative to seawater and have well understood chemistries within the marine environment. They occur in both fresh (continental) and saline (marine) groundwaters and thus the water source is often ambiguous. Here, we present a detailed investigation into the tidal circulation of seawater through animal burrows using Re-222 and isotopes of radium in the Coral Creek mangrove forest, Hutchinbrook Island, Queensland, Australia. The study was conducted at the end of the dry season in a creek with no freshwater inputs. Significant export of radionuclides and salt from the forest into the creek indicates continuous tidally driven circulation through the burrows. Results demonstrate that the forest sediment is efficiently flushed, with a water flux of about 30 L/m2/day of forest floor, which is equivalent to flushing about 10% of the total burrow volume per tidal cycle. Importantly, annual average circulation flux through mangrove forest floors are of the same order as annual river discharge in the central GBR. However, unlike the river discharge, the tidal circulation should be relatively stable throughout the year. This work documents the importance of animal burrows in maintaining productive sediments in these systems, and illustrates the physical process that supports large exports of organic and inorganic matter from mangrove forests to the coastal zone. It also illustrates the importance of considering saline groundwater sources when interpreting SGD radionuclide tracers in the coastal ocean.

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WATERSHED, HYDRODYNAMIC, AND WATER QUALITY MODEL FRAMEWORK TO SUPPORT DETERMINATION OF TOTAL MAXIMUM DAILY LOADS FOR INDIAN RIVER LAGOON TRIBUTARIES

The Indian River Lagoon (IRL) is a long, shallow estuary defined by barrier islands, tidal exchange at five inlets, and freshwater inflow from canals, the Estu Gallie, Sebastian and St. Lucie Rivers, Crane Creek and Turkey Creek. The biologically diverse IRL, an important natural resource for fishing, bird watching, boating, and swimming, has been adversely impacted by changes in land use, watershed loading, water quality and alterations in circulation with deterioration of ecological conditions. Under Section 303(d) of the Clean Water Act, Total Maximum Daily Loads (TMDLs) need to be developed to reduce loading of nutrients, organic matter, and sediments to achieve water quality targets established for the tributaries and canals of the IRL. The cause-effect interactions of watershed loading, circulation, and water quality were evaluated using the HFSP watershed model linked for input to the EPDC hydrodynamic, water quality and sediment diagenesis model. A unique feature of this study is that an EFDC model of the northern IRL was used to derive open water boundary data for fine-resolution nested EFDC models of the tributaries and canals. The EFDC model, calibrated and validated using hydrologic/water quality data collected in a dry year (2000) and an average rainfall year (2001), showed reasonable agreement with observed data for algae, dissolved oxygen, and nutrients. The HFSP-EPDC model framework, model results and the relative importance of watershed loads, open boundary conditions, water quality interactions and sediment fluxes on canal, tributary and mainstem results will be presented. The IRL model provides Florida DEP with a credible framework that is being used for TMDL evaluations in several tributaries (Eau Gallie, Sebastian, Crane Creek, Turkey Creek) and canals (North, Main, South, C-25).

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CONVERGING ON QUANTITATIVE MICROBIAL SOURCE TRACKING

Protocols for microbial source tracking of fecal contamination generally are able to identify when a source of contamination is present, but thus far have been unable to evaluate what proportion of fecal-indicator bacteria (FIB) came from various sources. Modern efforts to allocate FIB among sources (e.g., human, cattle, pets, etc.) have been hindered by inability of analytical methodologies to generate sufficiently discriminatory patterns or by imperfect sensitivity and specificity of host-associated marker sequences. Recent method improvements and application of novel mathematical approaches has resulted in validated semi-quantitative procedures for source allocation; these approaches have been applied to the Fountain Creek, Colorado and the upper reaches of the Ohio River following validation in reference aqueous fecal suspensions and a control watershed. Results obtained by use of the semi-quantitative would not have been possible using traditional approaches.

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MANAGING MULTIPLE STRESSES: THE SAGA OF SAGINAW BAY

Saginaw Bay, a large shallow embayment on Lake Huron, has been influenced by multiple stressors, and management efforts to mitigate their effects, for years. In 1978, target phosphorus loads were established to reduce eutrophication symptoms and in 1987 the bay was listed as a Great Lakes Area of Concern due to impairments including drinking water taste and odor problems, fish and wildlife consumption restrictions, animal deformities, loss of habitat, undesirable algae, and beach closings. In 1990, dreissenid mussels were discovered in the bay and the entire lake ecosystem has been fundamentally altered by changes in phosphorus cycling, light regime, and food web energy flow resulting from the filtering activity of these invaders. Increased muscle-induced phosphorus retention in Saginaw Bay continues to promote nearshore eutrophication problems. Concurrently, alewife, an invader that had become the primary planktivore in Lake Huron, has declined leading to altered commercial and recreational fisheries including a resurgence in the native Saginaw Bay walleye population. Meanwhile, the offshore Lake Huron food is collapsing from nutrient starvation. Thus, the dreissenid invasion has led to a growing dichotomy between nearshore and offshore regions and a dilemma for resource managers. Establishing water quality and fisheries management priorities has been difficult in this rapidly changing system; our project began by first meeting with resource managers to clarify the main uncertainties that limit effective management decision-making. Because the composition, density, and extent of the dreissenid population continues to change, management options in the short-run may be limited to mitigation of eutrophication symptoms, until the system stabilizes. Dynamics in this system underscore the value of an adaptive management approach guided by continued long-term monitoring coupled with synthesis via mathematical models.

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COMPARING NUTRIENT LEVELS AND PHYTOPLANKTON RESPONSE IN 3 NORTHERN GULF OF MEXICO ESTUARIES

Nutrients, both nitrogen and phosphorus, support algal growth in aquatic ecosystems. Yet, nutrient enrichment causes excessive algal growth leading to eutrophication, which can have negative impacts in coastal waters. The coastal zone of the Gulf of Mexico includes about 35 estuarine systems that vary widely in physical regime. We evaluate long term records (5-11 years) of nutrient and chlorophyll a levels from the National Estuarine Research Reserve System Wide Monitoring Program for seasonal and spatial patterns in three northern Gulf of Mexico estuaries: Grand Bay, Weeks Bay and, Apalachicola Bay. These systems have varying levels of human impact and environmental forcings such as freshwater and tidal influxes. Weeks Bay is a system characterized by high nutrient levels accompanied by high chlorophyll a levels (up to 387.33 μg/L). Dissolved inorganic nitrogen (DIN) concentrations range from 0.90 to 53.81 μM while dissolved inorganic phosphorus (DIP) concentrations range from 0.11 to 0.74 μM. Apalachicola Bay is a more marine system than Weeks Bay and, has lower chlorophyll a levels (0.57 to 22.57 μg/L). DIN concentrations in the area range from 3.78 to 3.78 μM while DIP concentrations range from 0.68 to 16.0 μM., except during April of 2005 when a fertilizer spill in the watershed led to values of 138μM. Apalachicola Bay, a
bar-built estuary heavily influenced by freshwater influx from the Apalachicola River, also experiences low to moderately eutrophic conditions (0.79 to 1.8 psu) supported by relatively low nutrient levels: DIN (0.79 to 34.07 mg/L) and DIP (0.03 to 2.27 mg/L). The effects of nutrient enrichment on algal growth of each system have been evaluated using nutrient bioassay experiments. Seasonal patterns of nutrient limitation on algal growth in each system will be investigated. Preliminary results show Weeks Bay and Apalachicola Bay is phosphorus limited, while Grand Bay is nitrogen limited.

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ACOUSTIC AND VIDEO EVALUATION OF COASTAL HABITATS BY SIDE SCAN SONAR COUPLED WITH REMOTELY OPERATED VEHICLE (ROV) SURVEY

Sites within the Mullica River-Great Bay estuary and offshore coastal artificial reef sites near the mouth of the Mullica River and Little Egg Inlet were surveyed with side scan sonar and remotely operated vehicle (ROV) A L-3 Klein 3900 dual frequency (445/900 kHz) digital side scan sonar was used to collect geo-referenced image data for surveys. A SeaBotix LBV ROV equipped with a BlueView P-900, 130° field imaging sonar was used to investigate previously mapped structures associated with habitat. In the estuarine surveys in depths from 1-7 m, a number of different structures such as logs, old pilings, lost crab pots and sunken small craft were detected and observed with associated fauna. Offshore sites were in depth ranges of 15- 20 m and part of the New Jersey Department of Environmental Protection Little Egg reef system. A diversity of artificial substrates including ships, barges, tanks, reef balls, and concrete castings were mapped and observed. Precise geospatial location allowed these sites to be accessed for repeated video and sonar imaging observation.

Characterization and enumeration of the communities surrounding these habitat structures has been undertaken to determine habitat preference and determinants of productivity of economically valuable fish stocks including black sea bass (Centropristis striata) and tautog (Tautoga onitis). In general, tautog preferred larger structures while black sea bass were associated with a wider variety of habitats. Seasonally, black sea bass appeared to move off the reefs in late fall to deeper water while tautog remained through the end of our field season in early December.

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INTEGRATING LIFE HISTORY MODELS, ENVIRONMENTAL DATA AND LONG-TERM MONITORING TO IDENTIFY FACTORS CONTROLLING RUPPIA MARITIMA DYNAMICS AT THE EVERGLADES-FLORIDA BAY ECOTONE

Ruppia maritima creates benthic habitat for fish, waterfowl, wading bird prey, marine mammals, elasmobranchs and other species at the Everglades-Florida Bay ecotone and is recognized globally as a critical foundation species for wildlife in variable environments, a growing condition with sea level rise and climate change. Plant population sustainability in each system will be investigated. Preliminary results show Weeks Bay and Apalachicola Bay is phosphorus limited, while Grand Bay is nitrogen limited.

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POTENTIAL PREDATION BY ARTHROPODS AND CRUSTACEANS ON RED MANGROVE PROPAGULES IN MOSQUITO LAGOON, FLORIDA

The red mangrove Rhizophora mangle reproduces by producing buoyant, viviparous propagules which may be damaged by predators before dispersal while attached to trees, during, and after dispersal when stranded in intertidal regions. In 2009 and 2010 we monitored growth and damage to Rhizophora mangle propagules while attached to trees in Mosquito Lagoon, Florida. In both years, 300 propagules were marked at the beginning of germination (May) on 23 trees at 3 sites; length, width and predation damage was recorded bi-weekly until propagules were ready for dispersal (August). To identify potential predators, in 2010 and 2011 we surveyed natural marsh (laphazard quadrats) and 15 R. mangle trees monthly for 12 months and recorded all fauna observed on trees and in marsh, and identified individuals to lowest possible taxa. In August 2009 and 2010, over 75% of propagules had pre-dispersal damage in the form of bite marks, holes, or scrapes along the exterior of the propagule. However, the presence of damage did not significantly affect propagule length and width relative to undamaged individuals, suggesting pre-dispersal damage does not negatively affect growth of propagules of R. mangle. (ANOVA: p<0.05). Potential propagule predators from seven different orders were recorded from R. mangle trees and quadrats and the most common organisms were arthropods. On-going studies are investigating R. mangle flower and propagule growth during the winter month and the frequency of propague predation during dispersal and post-dispersal in a natural marsh.

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THE EFFECT OF THE OIL DISPERANT COREXIT EC9500A ON BLEACHING OF THE ALCYONACEAN SOFT CORAL XENIA ELONGATA

Oil dispersants have been used since the 1960s to improve oil spill cleanup efficiency, but little toxicological data has been published regarding the effects of some dispersants on coastal environments. Corexit® EC9500A is a commonly applied dispersant that was extensively on the recent Deepwater Horizon blowout (April 2010). Despite the lack of solid toxicological data for coral reef species, there is limited evidence that Corexit® EC9500A can cause a bleaching response in corals. This study had two goals: (1) to determine the extent of bleaching after 24 and 96 hour exposures of sublethal concentrations (0-50ppm) of Corexit® EC9500A to the soft coral Xenia elongata and (2) to investigate the use of a percent bleaching calculation in acute exposure studies using zooxanthellae counts. For future chronic studies, I explored the possibility of spicule density and soluble protein concentration as zooxanthellae normalization techniques. My zoanthellae data suggested a strong correlation between exposure bleaching and percent bleaching in vivo. Percent bleaching was an effective measure of coral health in acute (24 hour) exposures. However,
zooxanthellae normalization with spicule density and soluble protein concentration in Xenia elongata was difficult because they may also be affected as a result of bleaching.

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DEWATERING OF ESTUARIES: NEKTION RESPOND TO ALTERATIONS IN FRESHWATER INFLOW

Many drainage basins have been modified by human demands for water, and the needs of a growing population are outpacing availability leaving some estuaries with very little freshwater. Given projected population increases and climate change, the competition for water will certainly increase. Clearly, understanding how reduction of inflow may affect estuaries is essential, and the Texas coast is an idealized natural experiment to study these processes. Texas’ major estuarine systems lie in a climatic gradient where runoff decreases from positive estuaries along the Louisiana border in northeastern Texas to negative estuaries in the southwest. The issue of dewatering of estuaries requires us to deal with a myriad of interactions within very dynamic estuarine ecosystems, while maintaining the fish and shellfish populations that support multi-million dollar fisheries. Surprisingly, few studies have quantitatively assessed the responses of fish to alteration to freshwater input to estuaries. Using this natural gradient, perturbations caused by freshwater inflow change were examined using a 32-year dataset from the Texas Parks and Wildlife Department. We used a boosted regression tree (BRT) modeling approaches to examine relationships between fish distribution and environmental variables, such as freshwater inflow and salinity, for the 25 most common species collected as well as species of economical importance for each major bay along the TX. coast. Many species showed strong responses in abundance to changes in inflow (i.e., salinity), and these approaches can be used to predict how estuarine nektone assemblages change under different inflow regimes. The nektion data presented here is a part of larger study to understand impacts associated with “dewatering” estuaries. The primary end products will integrate the responses of varied freshwater to estuaries and provide science-based information and tools for decision makers to ensure the future health of Texas estuaries.

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APPLYING THE COASTAL AND MARINE ECOLOGICAL CLASSIFICATION STANDARD (CMECS) TO SUB-TROPICAL SHALLOW WATER MARINE ECOSYSTEMS: CONTRASTING HABITAT MAPPING FOR BISCAYNE NATIONAL PARK TO COMMUNITY ECOLOGY

The Coastal and Marine Ecological Classification Standard (CMECS) offers a new framework for organizing scientific information about marine and coastal environments. CMECS facilitates applying consistent names and descriptions to ecological features and includes geology, chemistry, physics, and biology in a single structure. The application of CMECS to an intensively mapped and intensively managed sub-tropical coastal ecosystem of Biscayne National Park is presented. CMECS was crosswalked from the extensive map products and combined with reviewed literature to determine how information can be transferred to CMECS, and at what resolution. The use of a standard community classification in planning field studies that require site selection for change detection, restoration success or detecting alien invasive species is discussed. Biscayne Bay and associated reefs are ideal for examining the utility of CMECS with a almost 40-year history of restoration and management within the National Park.

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THROUGH THE BELLY OF A BEAST: WILL SEAGRASS SEEDS SURVIVE?

Animal mediated dispersal has been shown to enhance the germination and dispersal potential of seeds in many plant species. This mechanism has been well studied in terrestrial systems, but only limited research is available for seagrasses. This study examines the role of biotic dispersal in Ecgrass (Zostera marina) the dominant seagrass in northern temperate zones. We assessed the biotic dispersal potential of this seagrass using a range of vertebrate species including waterfowl, terrapins, and fishes, to determine excretion and germination rates of consumed eelgrass seeds. Here, we present evidence of eelgrass seed survival from consumption through germination. Over a three year study viable eelgrass seeds collected from Chesapeake Bay were fed to diamondback terrapins (Malaclemys terrapin), northern puffers (Sphoeroides maculatus), mummichogs (Fundulus heteroclitus), pinfish (Lagodon rhomboides), and lesser scaup (Aythya affinis). Seed viability was determined post excretion and seeds were monitored for germination. Excretion rates ranged from 59.1% in pinfish to 99.4% in mummichogs, while germination rates of excreted seeds ranged from 0.04% in diamondback terrapins to 91% in Northern puffers. Potential dispersal distances were then estimated from the gut retention time and daily movement rate of each species. Results suggest that biotic dispersal distances may be comparable to dispersal via abiotic mechanisms with the additional benefit of dispersal to areas limited in abiotic influences. Results suggest there may be an ecological benefit of biotic dispersal for this and other seagrass species.

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THE ST. LUCIE ESTUARY EXPERIENCE OF WATER QUALITY MODELING: FROM 3D TO 0D

The St. Lucie Estuary (SLE), a riverine estuary located on the east coast of South Florida is a complex system resulting from its channel system, altered water flow and degraded water quality. We developed an integrated modeling system consisting of a three-dimensional (3D) hydrodynamic model, a 3D sediment transport model and a 3D water quality model with the goal of evaluating management scenarios, for example, scenarios to meet the TMDL that was established in 2008. The hydrodynamic/salinity model has been calibrated with long term continuous monitoring data collected over a ten year period. The water quality model was calibrated with monthly water quality data over the same time period. Despite some uncertainties in the internal transformation and cycling, the nutrient and dissolved oxygen behaviors appear reasonably well in this transport dominated river system. However, significant challenges were encountered in modeling algae, partly due to the fact that available data did not indicate a compelling relationship between chlorophyll a and other variables including nutrients and light attenuation on monthly or seasonal scales. Other factors that might have contributed to the problem were lack of chlorophyll a data for boundary conditions and lack of data for algae growth rates, respiration and predation. To overcome these difficulties, simplified models including a box model or 0D model and a 1D model were developed. These simplified models made some analytical solutions possible that were useful for interpreting data and model results. The simplified models were calibrated with surprisingly good results for some constituents on certain time scales. The use of the simplified models is being further explored especially when combined with field data analysis. This may lead to better understanding of some biogeochemical processes and eventually a solid water quality model that can be truly helpful in assessing water management alternatives.

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PARADOX OF ALGAL BLOOMS IN OLIGOTROPHIC WATERS

In recent decades, the diatom Didymosphenia geminata has emerged as a nuisance species in river systems around the world. This periphytic alga forms large “blooms” in temperate streams and rivers, where phosphorus (P) availability typically limits primary production. We reveal a biogeochemical process by which D. geminata mats concentrate P from flowing waters. First, the mucopolysaccaride stalks of D. geminata adsorb both iron (Fe) and P. Second, enzymatic and bacterial processes interact with Fe to increase the biological availability of P. We propose that a positive feedback between total stalk biomass (Fe) and P. Second, enzymatic and bacterial processes interact with Fe to increase the
CONSIDERED SUITABLE FOR USE AS A BIOINDICATOR OF ATMOSPHERIC MERCURY CONCENTRATIONS?

Mercury is a toxic heavy metal that is transported globally in vapor form. A major source of mercury contamination to soil, water, and biota is atmospheric deposition. Coastal benthic sediments provide optimal conditions for conversion of deposited mercury to methylmercury, a harmful neurotoxin. Therefore, comprehensive monitoring of atmospheric mercury concentrations is important, particularly in coastal environments. Conventional air sampling techniques are costly and require extensive sampling to obtain sufficient data for temporal and spatial integration of deposition patterns. Spanish moss (Tillandsia usneoides) is a potential bioindicator of atmospheric mercury concentrations in the southeastern United States because it is an abundant epiphyte in coastal areas that absorbs and accumulates atmospheric pollutants. A study was conducted in southeast Georgia to test the hypothesis that mercury concentration in Spanish moss tissue is affected by atmospheric mercury concentration. To determine the relationship between Spanish moss tissue mercury concentrations and local atmospheric levels, we sampled Spanish moss from populations in locations with various levels of human impact. In addition, to determine how concentrations in Spanish moss change in response to elevated atmospheric concentrations, we transplanted Spanish moss with low background levels to sites that have known sources of mercury emissions. In both experiments, tissue was analyzed for mercury concentration using Inductively Coupled Plasma Mass Spectrometry. Preliminary data suggest Spanish moss absorbs mercury rapidly in response to elevated concentrations, and coastal wetland habitats are associated with high levels of mercury in the atmosphere. Thus, if Spanish moss reflects atmospheric mercury concentrations, then this plant could provide a useful measurement tool to add to existing monitoring protocols.

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DEVELOPING NUTRIENT CRITERIA FOR CALIFORNIA ESTUARIES: PROCESS, CONCEPTS AND DATA GAPS

Eutrophication of estuaries is a global problem, causing a host of adverse effects including hypoxia, harmful algal blooms, decreased biodiversity and alteration of food webs. Within the state of California (USA), conversion of land for agriculture and urbanization has greatly increased nutrient loads to estuaries. However, the extent and magnitude of problems from eutrophication are not well quantified and water quality criteria do not yet exist. The State of California is developing a comprehensive approach to establish additional water quality criteria in the State’s aquatic habitats. This approach is founded on the use of ecological response indicators, such as algal biomass and dissolved oxygen, rather than nutrient concentrations, to diagnose eutrophication. Models are then used to link response indicators to nutrients and other co-factors to establish site-specific targets and establish NPDES permit limits. Draft criteria based on ecological response indicators and model linking the indicators to nutrients have been developed for streams and lakes and are under development in estuaries. This talk will explore the conceptual approach, ongoing scientific studies, and data gaps associated with applying this framework to California estuaries and compare California’s approach with other regulatory approaches.

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ASSESSMENT OF REGIONAL VARIATION OF DRIVERS OF WATERSHED NITROGEN EXPORT TO COASTAL WATERS USING SPARROW AND NANI

We estimate riverine nitrogen flux from coastal watersheds (NOAA estuarine drainage areas or EDAs) in the contiguous US using the USGS SPARROW (Sedimentation and Phosphorus, Attributed to Rivers and Point Sources) approach, which accounts for non-point sources of nitrogen to estuaries. The SPARROW approach emphasizes watershed characteristics and their influence on nitrogen transport from sources to watershed export. Regional differences in the dominant terms of NANI (e.g., N deposition vs. fertilizer application) and in watershed attributes in SPARROW suggest the importance of considering regional characteristics for managing nutrients in coastal waters and their watersheds.

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A GEOCHEMICAL AND GEOPHYSICAL INVESTIGATION OF THE GEOLOGIC CONTROLS ON COASTAL GROUNDWATER EXCHANGE IN COPANO BAY, TEXAS

The persistent exchange of groundwater with coastal bottom water can impact materials budgets and coastal ecosystems. Both anthropogenic and natural processes can affect the quantity and quality of coastal groundwater that discharges to the nearshore. In this study, we examined the geologic control of coastal aquifers in Copano Bay, Texas (USA), by combining geochemical and geophysical tools to identify zones of preferential subsurface flow and assess the potential for groundwater recharge and discharge.
flow, and 2) quantify rates of subaqueous groundwater discharge (SGD). Excess surface-water radon-222 (222Rn) activities from multi-day, time series deployments at four sites distributed around the perimeter of the bay were modeled to obtain site-specific SGD rates. 222Rn was also continuously measured for more than 24hr in deep and shallow groundwater wells (mean 222Rn ~ 637,000 and 395,000 dpm m-3, respectively), and a shallow piezometer located about 10 m from the south shore (mean 222Rn ~ 37,000 dpm m-3).

Multiple-channel electrical resistivity surveys using both land-based and continuous resistivity profiling (CRP) modes were conducted to better characterize lithologic and hydrologic controls on surface water-groundwater exchange. Preliminary results confirm active exchange of groundwater across the sediment / water interface in some areas of Copano Bay. Pathways and conduits for this exchange are likely controlled by both Pleistocene antecedent geology and Holocene bay fill strata. Implications of historic and modern coastal groundwater exchange are considered for such features at the buried oyster reefs and fringing wetlands.

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THE IMPORTANCE OF HYDRODYNAMIC REGIME IN REGULATING ORGANIC MATTER IMPACTS FROM FISH FARMING ON BENTHIC ECOSYSTEM FUNCTIONING

The Norwegian coastal zone is impacted by a variety of non-point (e.g. agriculture) and point-stressors, such as aquaculture. Net.-pen fish farming in Norway has increased dramatically in the last 2 decades and as of 2005, reported aquaculture production stood over 600,000 tonnes. Successful, environmentally friendly coastal management strategies need to be able to sensibly site farms along the coastline. This is particularly important today given that the aquaculture industry is growing and new fish-farm locations need to be proposed. Suitable management policies, do however require a detailed understanding of how benthic ecosystems operate under nutrient stress and how physical factors such as hydrodynamic regime influence ecosystem processes - all of which are poorly known. We used stable isotope labelled algae as a deliberate tracer to analyze benthic ecosystem functioning.

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DYNAMICS OF NERITIC ICHTHYOFANAL ASSEMBLAGES IN THE EASTERN GULF OF MEXICO: IMPLICATIONS FOR SUSCEPTIBILITY TO BROAD-SCALE ENVIRONMENTAL PERTURBATIONS

Although the importance of routine monitoring surveys has long been recognized, the 2010 Deepwater Horizon oil spill has brought to the forefront the importance of baseline data to assess the impacts of environmental perturbations on coastal living resources. An understanding of natural variability in pristine ecosystems is essential to quantify impacts of ecological stressors. To address these needs, we characterized temporal and spatial dynamics of demersal ichthyofaunal assemblages in the northeastern Gulf of Mexico. Data were collected during seasonal (summer and fall) trawl surveys in 2008 and 2009 in association with the recently-expanded SEAMAP groundfish survey. Temporal differences in assemblage structure were minor, and primarily attributable to generally higher nighttime catches for most taxa with the exception of several schooling pelagic fishes; significant seasonal differences were not detected. Spatial differences were much more evident. Significant depth-related differences in assemblage structure were detected, especially in association with the twenty-fathom contour. We also detected a significant regional faunal shift near Cape San Blas, Florida (85°W). This shift was driven principally by higher abundances of taxa typical of the north-central Gulf of Mexico to the west of Cape San Blas, as well as higher abundances of juvenile reef-associated taxa to the east. Observed differences in assemblage structure may result from several factors, including physiochemical conditions, benthic habitat composition, and regional hydrodynamics, although the relative importance of these and other potential factors is not clear. Continued efforts to unravel the relationship between assemblage structure and these environmental factors will ultimately lead to a better understanding of the relative susceptibility of northeastern Gulf of Mexico ichthyofauna to pervasive environmental threats (e.g. oil spills, red tide).

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BALANCING THE RECREATIONAL USE AND PROTECTION OF FLORIDA'S WATERWAYS

Coastal communities face the challenge of balancing the use and protection of their waterway resources. Over four decades, Florida’s coasts were transformed as population growth and demand for shorefront property led to the creation of residential canal developments. Thousands of miles of channels were dredged as a by-product of this process, and boaters soon followed. A result is that navigable waterways and aquatic resources are stressed by increasing boat traffic and related activities. Recognizing a common goal to preserve the recreational and ecological value of Florida’s waterways, the Florida Department of Environmental Protection, the West Coast Inland Navigation District, which serves four counties that contain 8% of Florida’s population and 12% of its registered boats, and the Florida Sea Grant College Program signed a Memorandum of Agreement. The signatories agreed to develop a science-based Regional Waterway Management System (RWMS): a new approach to waterway planning and permitting based on carefully mapped channel depths, a census of boat populations, and the spatial extent of aquatic resources. The GIS-based RWMS provides a comprehensive, regional overview of channel conditions and the geographic distribution and severity of existing impediments to safe navigation and resource protection. RWMS information and analyses result in regional-scale permitting to accommodate water-dependent uses while minimizing environmental impacts and reducing public expenditures. The adoption of the RWMS by the State of Florida and implementation of the state administrative code demonstrate the ability of sound science to guide state waterway management activities. Benefits include: (1) state policy based on “best available science,” (2) better efficiency and effectiveness in waterway maintenance, (3) savings in dollars and staff time, and (4) better public policy through holistic, ecologically based decision-making that is predictable, fair, and cost effective.

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INTERACTIONS BETWEEN SEDIMENT, HYDRODYNAMICS AND SUBMERSED AQUATIC VEGETATION IN THE CHESAPEAKE BAY

The long term decline of submersed aquatic vegetation in the Chesapeake Bay, USA, has focused significant attention on the challenges facing restoration efforts. Restoration projects tend to focus on light requirements as the primary factors influencing success. However, it has been shown that sediment organic content, grain size, and local hydrodynamics are also key factors controlling SAV growth and morphology, suggesting that restoration site selection should also take these factors under consideration. We hypothesize that SAV growth will be most successful under moderate suspended transport conditions because of the constant stream of fine and organic particles, which support growth, that will be supplied without allowing the sediment organic content to reach toxic levels. Bedload transport may also encourage recruitment through seed burial. To show this, we measured the sediment grain size and organic content, wave exposure and current velocity, and SAV biomass and morphology inside healthy beds. This data was used to determine sediment transportation potential of each site and to consider relationships between SAV health and physical habitat parameters. Further, we predict that this trend is consistent throughout different regions/ecotones of the Bay.
ABSTRACT

HABITAT SAPROBITY AND BENTHIC SUCCESSION IN COASTAL TRANSITIONAL ECOSYSTEMS

We delineate the concept of habitat saprobity as a state of an ecosystem resulting from numerous processes of organic matter (OM) metabolism. We review and expand upon classic conceptual models describing the succession of benthic communities along a gradient of organic enrichment (e.g., Pearson & Rosenberg, 1978; P-R) or confinement (e.g., Guifrontet & Perlhuis, 1983; G-P). Similarities between different approaches and models are highlighted, whereby the P-R and G-P models are unified under a single conceptual framework. Based on a critical analysis of existing models and indices, we propose a general framework where the processes of OM metabolism are a major structuring factor the benthic communities in coastal lagoons, and saprobity is used as a state descriptor of these processes. We assume that saprobity cannot be quantified by considering only the amount of OM per se. In fact, saprobity is the result of both input of OM and other processes, such as mineralization, burial, dilution and export of OM. The same organic input can, therefore, generate different degrees of saprobity in different systems and in different areas within a system. In addition, saprobity acts on benthic communities together with other components of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type. Due to difficulties to quantify saprobity itself, we foresee the use of benthic communities and the memberships of the transitional gradient, such as salinity and sediment type.
water quality standards for dissolved oxygen, any future revisions of the TMDL will still need to deal with uncertainty and would benefit from phasing. Adaptive management must be fully embraced, particularly to incorporate management of waterbody processing of nutrients in addition to watershed loading.

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**DEVELOPING NUMERIC NUTRIENT CRITERIA FOR STREAMS IN A CHEASPEAKE BAY RIVER BASIN**

The Choptank Estuary experiences high chlorophyll a and low dissolved oxygen due to terrestrial anthropogenic inputs of excess nitrogen and phosphorus from streams in the Choptank River basin. Seventy-seven percent of stream samples from the basin had nutrient concentrations higher than ecoregional total phosphorus criterion (0.031 mg P L⁻¹) suggested by the U.S. Environmental Protection Agency, and 97% exceeded the suggested total nitrogen criterion (0.71 mg N L⁻¹). These high nutrient contributions contribute to the impairment of the Chesapeake Bay. To determine if non-tidal numeric nutrient criteria would be protective of the Choptank Estuary, additional nutrient criteria were derived that were consistent with the nitrogen and phosphorus loading goals provided in the Watershed Implementation Plans as part of the multi-state Chesapeake Bay Total Maximum Daily Load (1.43 mg N L⁻¹ and 0.157 mg mg P L⁻¹). In addition, criteria were derived that would keep the chlorophyll a values below 15 μg L⁻¹ in the Choptank Estuary, accounting for dilution by Chesapeake Bay water and burial and denitrification in subtidal sediments and intertidal wetlands (0.84 mg N L⁻¹ and 0.049 mg P L⁻¹). These two approaches resulted in numeric nutrient criteria only slightly higher than those recommended by EPA. The exception was 0.157 mg mg P L⁻¹, which was five times the suggested total phosphorus criterion. Only eleven percent of streams exceeded this value, and 54% exceeded the total phosphorus value calculated using the chlorophyll a approach. A high percentage of streams in the basin still exceeded the total nitrogen values (89 and 96%). These multiple approaches to numeric stream nutrient criteria provide greater confidence that significant improvements in the Choptank Estuary will occur if the criteria are adopted and enforced.

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**ASSESSMENT OF EUTROPHICATION PARAMETERS SPATIALLY THROUGHOUT CHOTAWATHCHEE BAY, LOCATED IN THE PANHANDLE OF FLORIDA**

Chotawatchee Bay is located in the Panhandle Region of Northwest Florida. The Chotawatchee Basin Alliance of Northwest Florida State College (CBA) has been coordinating monthly water sampling within the Chotawatchee Estuary for over 10 years. Long-term averages for total phosphorus, total nitrogen, chlorophyll and water clarity were calculated for the entire Chotawatchee Bay. Mean total phosphorus was 17 μg/L, mean total nitrogen was 318 μg/L, mean total chlorophyll was 4.9 μg/L and mean Secchi depth was 2.0 m. Sixty percent of the sites sampled were phosphorus limited, 6% were nitrogen limited and 34% of the sites were either phosphorus or nitrogen limited. Spatial variability throughout Chotawatchee Bay was also assessed. Three regions were established by plotting long-term surface salinity means by longitude for each site. Region 1 included sites located near the East Past (west side) and had means that were consistently above the long-term mean for the bay. Region 2 included sites in the middle of the bay and included sites that had means that fluctuated above and below the long-term mean for the bay. Region 3 included sites near the river side of the bay (east side) and had means that were consistently below the long-term mean for the bay. Spatial differences in water quality were further evaluated by calculating water chemistry averages of eutrophication parameters for each of the three regions. All parameters were statistically different across the three regions. The three regions will be presented with the water chemistry means and statistical analyses of each region. Groups like CBA are providing extensive baseline data for researchers and managers to use to assess the effect of land use changes on eutrophication parameters, determine temporal changes on water chemistry parameters, and to assess the overall health of Florida’s waters.

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**PRODUCTION AND TRANSPORT OF ORGANIC MATTER TO FUEL HYPOXIA IN CHEASPEAKE BAY: A MODELING ANALYSIS**

Much of the ongoing effort to restore water quality and living resources of Chesapeake Bay is focused on reducing the extent and intensity of oxygen-depleted bottom water by decreasing pollution loading (mostly excess nutrients) to the estuary. The response of Chesapeake Bay dissolved oxygen changes to nutrient loading is modulated by both external climatic and hydrologic forcing, as well as internal biogeochemical interactions. Numerical models are needed to simulate these varied and complex biological and physical processes in order to understand their contribution to the cycling of dissolved oxygen. Many such coupled hydrodynamic-biogeochemical models currently fail to accurately capture the seasonal cycle of bottom-water dissolved oxygen in Chesapeake Bay, perhaps because they fail to generate and transport the organic matter necessary to fuel the observed patterns of O₂ depletion. We present analyses of two coupled hydrodynamic-biogeochemical models for Chesapeake Bay, each with different spatial resolution, to examine this problem. One model is driven by regional transport fields over a regional, 18-cell domain, while the second is driven by a high-resolution implementation of ROMS for Chesapeake Bay. We use these models to test the hypotheses that interannual variations in oxygen depletion in mesohaline Chesapeake Bay are highly influenced by previously under-valued spring and summer sources of organic matter from (1) landward bottom-layer transport along the central Bay channel and (2) lateral transport from shallow shoals into the deeper central channel.

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**ECOLOGY AND HYDROLOGY OF RESTORING WETLANDS IN THE LOWER COLUMBIA RIVER ESTUARY**

Our primary research objectives between 2004 and 2010 were to (1) synthesize field research on ecological responses associated with tidal wetland restoration projects in the Lower Columbia River estuary (LCRE), (2) evaluate indicators for assessing restoration response, including analysis of ecological relationships, and (3) recommend performance monitoring as well as aspects critical to restoration in the ecosystem. The LCRE, which includes the 235 km long region between Bonneville Lock and Dam and the mouth of the Columbia River, is a drowned river valley that drains a 724,025 km² river basin, with a mean discharge today of 7,730 m³ s⁻¹. Like other estuaries, loss of tidal wetlands in the LCRE has been substantial. Tidal forested (spuce) swamp and tidal marsh habitats have suffered the largest relative declines. Much of the loss is attributed to diking for agriculture purposes, filling, and flow operations. Our studies of newly restoring sites documented a clear response of vegetation to restoration actions within one year following tidal hydrology reconnection, redevelopment of historical tidal channels, exposure of buried logs and stepped pool morphology in channels, initiation of sediment accretion in subsided areas, improved water quality conditions, frequent and prolonged use of restored site by estuarine-dependent juvenile salmon, use of tributary habitats by out-of-tributary salmonid stocks, nutrient processing and export of marsh organic matter, a non-linear response in floodplain area with an increase in levee breaches, and evidence of synergism among sites within a tributary. Initial responses indicated a positive trajectory toward restoring ecosystem structure, processes and functions. We conclude that, tidal hydrology reconnection in the floodplain would lead to a cumulative net improvement of the estuarine ecosystem, and that the rate of recovery would vary substantially among habitats types from a decade to a century or more.

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**RESTORATION OF NUTRIENT-ENRICHED EVERGLADES THROUGH PHOSPHORUS LOAD REDUCTION AND FIRE**

Ecologists have tackled questions concerning ecosystem health including how a system is exposed to, responds to, and recovers from nutrient enrichment. This was a study of natural recovery in the phosphorus (P)-enriched Everglades and an evaluation of the use of fire to accelerate recovery. The study was conducted at a highly- and moderately-P enriched wetland. After 15 years of reduced P loading, natural recovery was apparent. Recovery trends differed between the highly- and moderately-enriched areas. Water quality recovery in the highly-enriched area was highly correlated with P loading reduction. Plant and soil P concentrations decreased slowly over time yet were still twice as high as the moderately-enriched area. In contrast, surface water P did not decline in the moderately-enriched area. While plant and soil P concentrations also did not demonstrate significant declines, burial of nutrient-enriched soil below lower P-concentration soil was apparent. Overall, reducing P loading was the crucial first step for ecosystem natural recovery. Application of fire to accelerate recovery resulted in the removal of 0.1 to 0.7 g Pm⁻² depending on nutrient- enrichment level and water depth at the time of fire. A temporary surface water P pulse with ash return was observed after each fire. Cat tail was stressed by fire resulting in a reduction in primary production and shoot base P concentration, while sawgrass plants were positively impacted by fire. The increase in sawgrass seed germination after fire indicates that surface fire may be an effective tool for the reestablishment of the historical Everglades plant community. However, the seed bank in the highly-enriched area was devoid of sawgrass and contained numerous undesired species. These results indicate that fire may be an effective
management tool in the moderately-enriched area, while in highly-enriched area, the use of fire may require additional measures to prevent colonization of undesirable species.

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LESIONS LEARNED FROM THE NATURAL RESOURCE CONDITION ASSESSMENT PROGRAM

The National Park Service in the USA is assessing natural resource conditions in 270 national parks across the country. Assessments have been completed for Rock Creek Park, Antietam National Battlefield, Monocacy National Battlefield, Manassas National Battlefield Park, and Assateague Island National Seashore, and assessments are currently underway for Colonial National Historical Park, Catoctin Mountain Park, Harpers Ferry National Historical Park, and Chesapeake and Ohio Canal National Historical Park. These parks were established for a variety of reasons, including natural, cultural, and historical significance; however, some overarching lessons on how to proceed through these assessments have been learned. One of these lessons is using a conceptual framework for conducting these assessments. This framework defines desired and degraded conditions for the park’s natural resources and provides a structure for assigning and assessing metrics against these desired and degraded conditions. Another lesson learned is that of combining innovative scientific communication with clear data synthesis and analysis. In contrast to many other assessment reports, these condition assessments are presented in full color with conceptual diagrams depicting the desired vs. degraded assessment framework and synthesizing the results in an attractive and easy-to-understand design. The future direction of these assessments will also be presented, with a view to combining natural and cultural resources in the assessments to better facilitate a discourse between natural and cultural resource managers and provide better support for interdisciplinary park management.

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RECRUITMENT AND GROWTH OF SPAT OYSTERS (CRASSOSTREA VIRGINICA) IN SAN ANTONIO BAY, TX FOLLOWING PROLONGED DISTURBANCE EVENTS

Since the fall of 2003, oyster (Crassostrea virginica) spat recruitment has been examined seasonally, among years, and at different locations in San Antonio Bay, TX to document the pace and spatial variation with which oysters repopulate established reef habitats following disturbances such as prolonged freshwater inflow events. Metrics included spat occurrence, spatial distribution, shell height and density (#/kg wet culch). Size class distributions of adults were also determined to document general disturbance effects. During each sampling, spat oysters (>10 mm and having the characteristic flat, thin shell of a juvenile) were collected from up to 4 reefs representing an upbay/downbay gradient. Each sampling consisted of hand or shallow water oyster dredge collections of similar wet weights of culch from three locations at each reef. Successful spat recruitment was documented following four periods of protracted freshwater inflows into San Antonio Bay and the Guadalupe Estuary (2004-05, 2006-07 and 2009-10). The most sizeable spat recruitment occurred during 2008, following our October 2007 survey. In October 2007 we documented nearly complete oyster mortalities inside and outside the Intracoastal Waterway, extending as far downbay as Panther Point reef, off Matagorda Island. However, by January 2009 spat had not only recruited back onto the uppermost reefs but had grown to reproductive sizes (up to >100 mm in some cases) within 15 months, yielding valuable information about growth rates following a major disturbance event. Oyster population size structure and recruitment varies considerably among sites, seasons and years. Uplift populations tend to be more prone to flood disturbances but grow more quickly after they are recolonized. However, the oyster population in San Antonio Bay has demonstrated remarkable resilience following disturbances which might be helpful in cleaning culch, delivering food material, and “resetting the clock” in the estuary.

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ABUNDANCE AND TRANSPORT OF MERCENARIA MERCENARIA LARVAE IN WAQUOIT BAY, MA IN 2009

Mercenaria mercenaria, commonly known as quahogs, are important commercial bivalves on Cape Cod. Quahog populations in Cape Cod bays are regularly supplemented with seed to enhance recreational and commercial shellfishing. An inability to identify larval quahogs in the plankton has limited the effectiveness of enhancement in terms of spawning success and recruitment of larvae in seeded areas. New technology using pattern recognition of larval shells under polarized light has enabled the identification of quahog larvae from field samples with 80-90% accuracy. We used this polarized light image analysis method to identify M. mercenaria larvae from a series of 2009 studies assessing abundance and transport of bivalve larvae in Waquoit Bay, an embayment on the south shore of Cape Cod. Although quahog larvae had high abundance and growth throughout the bay, export of larvae was spatially observed at high-frequency studies at a specific location. Stratiﬁed sampling studies showed little evidence of tidal periodicity in transport that may encourage retention. Larvae swept into upstream areas on strong ﬂood currents are capable of being retained, and this is evident from a recent increase in two year old littleneck clams from the 2009 spawning season. By enabling us to capture quahog transport in a year of high recruitment, this study demonstrates the importance of species-speciﬁc information in bivalve larval studies to aid management decisions and directions.

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PROSPECTS FOR CONSERVING ENDANGERED WILDLIFE POPULATIONS IN PACIFIC COAST SALT MARSHES UNDER EXPECTED SEA-LEVEL RISE

Coastal salt marshes and estuaries are projected to be disproportionately impacted by climate change and sea-level rise, according to the Intergovernmental Panel on Climate Change. Over 80% of historic wetlands in the San Francisco Bay, CA estuary have been lost to urban development and landscape modification. The San Francisco estuary, though severely fragmented and modified, is one of the largest tidal marsh complexes in the western United States 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 endangered species, but it remains unknown how much of an effect sea-level rise may have on the amount and quality of habitat. The focus of this interdisciplinary study is to evaluate sea-level rise impacts to salt marsh habitats and wildlife by synthesizing field data and modeling in order to develop and evaluate habitat impact models. Our work illustrates the variable risk to wildlife species and identifies critical sea-level rise thresholds for the species of San Francisco estuary salt marshes. For this study, elevation data was collected using a RTK GPS, which was used to build elevation models for 13 salt marsh sites around San Francisco Bay. In addition, sediment modeling, vegetation characteristics relative to elevation and tidal inundation patterns were also established for all marsh sites to better understand potential future habitat changes. Our models project that a 0.3 m rise in relative sea level will inundate vegetative habitats at 80% of our sites, which may render them unsuitable for current wildlife species. We hypothesize that a relatively small rise in sea level may result in increased drowning, nest failure and an increase in predation pressure for these obligate species. Habitat impact models and ongoing research objectives will be presented.

Work is currently being expanded to other Pacific coast areas.

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A CONCEPTUAL MODEL FOR DETERMINING COASTAL VULNERABILITY IN A MACROTIDAL ENVIRONMENT

This research aimed to produce a globally applicable framework in order to assess vulnerability in a macrotidal environment by constructing a consistent and comprehensive conceptual model. In climate change assessments, vulnerability is a term that requires adequate definition, in order to avoid misunderstanding; especially in interdisciplinary research concerning vulnerability and adaptation. The framework for the model begins by clearly defining vulnerability in the context of the specified system (biophysical, socio-economic), type of hazard (erosion, sea level rise, storm surge) and time (short vs. long-term exposure). Within the literature, the most common factors or variables utilized in coastal vulnerability assessments include coastal slope, coastal geology, dominant wind/wave direction, fetch, width of foreshore and the presence of barriers/obstacles. However, in a macrotidal environment, such as the Bay of Fundy, Nova Scotia, the driving force behind the dynamic influence of these variables is the changing tide level. In the short term, impacts from hazard events such as storm surges will be hindered or amplified depending on the tide level at land fall. In the long term, the large energy flows characteristics of a macrotidal range will influence exposure to erosion. This conceptual model, specifically oriented to
define coastal vulnerability for the Bay of Fundy, is particularly important due to the dynamic complexity of the influencing factors and their relationship with changing tide level.

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INTEGRATING UNDERGRADUATE RESEARCH EXPERIENCES IN COASTAL AND ESTUARINE RESEARCH: EXPERIENTIAL EDUCATION USING AUTHENTIC RESEARCH AT THE CAPE ELEUTHERA INSTITUTE

The interdisciplinary nature of marine sciences provides an excellent platform for using a learning-based approach that incorporates experiential education and authentic research. Such an approach can help students better understand the complex interrelationships and processes of marine ecosystems that are often difficult to conceptualize in a traditional classroom setting. The Cape Eleuthera Institute (CEI), located in Eleuthera, The Bahamas, offers a unique opportunity for students to learn about tropical environments and participate in ongoing research projects conducted by scientists while being fully immersed in a unique and dynamic environment. Each January, Monmouth University undergraduates majoring in marine and environmental biology and policy spend two weeks at CEI working side-by-side with scientists investigating flats ecology, patch reef ecology, and sustainable resource management. For example, Monmouth students are working with CEI to document the distribution and abundance of long-spined sea urchins on patch reefs around Cape Eleuthera. In addition, urchins are being transplanted from patch reefs where populations are thriving to reefs devoid of urchins. Monmouth students have also been collecting data that documents a decline in the size of queen conch harvested around Cape Eleuthera, a direct sign of overfishing. These data are important for developing effective management measures for sustaining the fishery over time. Finally, to assist researchers studying flats ecology, Monmouth students have participated in efforts to track bonefish movement between flats and other habitats critical to their life cycle and investigations of feeding behavior of bonefish in flats ecosystems. Collectively, these experiential education opportunities help students achieve a greater understanding of applied research necessary to inform resource conservation and management decisions.

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TRAITS VARIATION OF SEagrASS SPECIES IN RESPONSE TO DISTURBANCE OVER A GEOGRAPHIC SCALE

Different scales of diversity from genetic to community may interact with each other and disturbance to alter diversity disturbance relationships. Trait diversity of foundation species can have important ecological consequences by affecting habitat structure and stability, particularly in communities where species diversity is low. Intra-specific diversity (e.g., morphologic, genetic) of foundation species may confer resistance to disturbance events, as well as alter associated communities diversity by creating more structurally diverse habitat and refuge area. We hypothesized that as morphologic trait diversity increases, associated community diversity will increase, with morphologic trait diversity becoming more important as disturbance frequency/intensity changes. We conducted a survey of morphologic traits (seagrass), associated community diversity (epifauna and infauna), and disturbance regimes in seagrass communities across a geographic scale during the seagrass summer growth season. Quadrats were used to assess morphologic traits of individual ramets. Associated community diversity was quantified with morphology to relate epifauna and infauna diversity to above- and below-ground seagrass morphologic traits, respectively. We assessed the proportion of bare space within a seagrass bed, which represents biomass gain/loss. At sites where disturbance history is unknown this measure can be used as a proxy for disturbance. Our previous studies have shown that key seagrasses (e.g., Thalassia testudinum) morphologic traits that significantly vary between sites are shoot density, number of roots, number of root scars, sheath length, and youngest leaf length. Belowground attributes showed the strongest morphologic variation, which may provide a wider range of resistance to a greater range of disturbances (e.g., T. testudinum rhizome diameter range 0.36 – 0.74 cm in Indian River Lagoon, Florida).

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AN ASSESSMENT OF “PRE-OIL” BASELINE CONDITION OF FLORIDA COASTAL HABITATS WITH LOW-LEVEL, OBLIQUE AERIAL PHOTOGRAPHS

In response to the potential impacts from the Deepwater Horizon spill event, the U.S. Geological Survey collected low level (500 ft) oblique aerial photographs to document the “pre-oil impact” condition of coastal habitats from the mouth of the Suwannee River to the Florida Keys. Digital camera systems with synchronous GPS units were employed whereby photographs were instantaneously tagged with latitude and longitude and then downloaded into laptop computers. In the laboratory, photographs were post-processed to correct the color for tintering on the aircraft’s windows. Over 2,500 km of flight lines were flown with more than 20,000 individual photos taken. Included in the overflights were all or part of 17 National Wildlife Refuges, three National Parks, and 24 State of Florida Aquatic Preserves/State Parks. Habitats of special concern such as turtle nesting beaches, estuaries, marshes and mangrove forests were also photographed. In ArcGIS, we created a geodata housing layers of critical species habitat, conservation and/or managed lands, wetland inventories, and vegetation cover along with our flight lines and raster images. Additionally, our flight lines and raster images were saved as KML files for viewing in Google Earth. The photos are being used to establish a “pre-oil impact” baseline and will be useful for several other purposes. For example, the USGS Coastal Hazards group (and other teams) can use them in the event of a hurricane or tropical storm striking the area. For areas such as the J.N. “Ding” Darling National Wildlife Refuge, the photos are being used to assess mangrove forest recovery, or lack of recovery, some six years after the refuge was hit by Hurricane Charley. Impacts of the January 2010 cold/freeze event to mangroves are also being assessed.

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ESTUARINE FLOCCULATION - MODELLING THE FATES OF SUSPENDED PARTICLES

Suspended particulate matter (SPM) determines turbidity, impacting both water quality and primary production. SPM generates benthic fluff on the seabed, modifying biogeochemical exchanges and constraining primary productivity. Further, SPM carries important biogeochemical components (e.g., carbon, nitrogen, contaminants and pollutants), deciding the fates of anthropogenic inputs to the estuarine system. Outside of the non-cohesive fraction (sand), little is known of the properties of SPM (i.e. particle size, density, settling velocity) and how these impact fine particle entrainment and sedimentation. This is due to most SPM being in the form of flocs (aggregates of dead and living organic matter, cohesive inorganic matter, and water) that are dramatically modified by conventional sampling methods (easily ruptured and/or may aggregate during sampling). As such we lack reliable and comprehensive information on key parameters such as pick-up functions and settling velocities, particularly since floc properties change on a range of time scales: tidal (suspension/advection), lunar (spring-neap cycle), and seasonal (storm resuspension and biological production). Turbulence is an important mediator of floc characteristics, with low Reynolds numbers promoting particle collision and aggregation, while higher Reynolds numbers result in shear-induced rupture: literally tearing aggregates apart. Because of this, accurate turbulence parameterisation is key to successful modelling in this field. The results of an extensive field campaign and SPM flux modelling of the Dee estuary (N.W. Britain) are presented, giving insight into the fates of both riverine input and advected SPM from offshore. Using data from a combination of acoustics, optics, moored deployments and CTD stations, a 1-D model shows variation across both tidal, spring-neap, and seasonal time-scales.

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To understand how variable freshwater inflow influences prey production for estuarine-dependent fishes, we examined spatiotemporal trends in zooplankton (including hyperbenthos) and water quality parameters along the Caloosahatchee Estuary. During wet months the low salinity zone (LSZ), a region that in other estuaries serves as nursery habitat for early life stages of certain fishes, was blocked from moving farther upstream during dry months by the presence of the lock and dam, suggesting additional habitat compression as their upstream distributions are truncated. In addition to changes in center of distribution in response to inflow, some taxa exhibited significant changes in total abundance in response to lagged inflow, the majority of which were negative, indicating reduced system-wide abundances at higher levels of inflow. These contrasting patterns, habitat compression during periods of low inflow and potential advective washout during periods of high inflow, have significant implications for the management of freshwater inflow in the Caloosahatchee Estuary.

**Managing Freshwater Inflow to Optimize Prey Production for Young Estuarine–Dependent Fishes in the Caloosahatchee Estuary**

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above, but also can serve to underpin coastal management and policy decisions. This presentation provides an overview of recent efforts to develop such a sea-level database for the Atlantic and Gulf coasts of the United States. First, the methodology to reconstruct former sea-levels is defined, with particular reference to the quantification of age and elevation errors. We highlight a number of errors associated with 14C dating that have rarely if ever been considered in previous studies of this nature, plus the role of palaeotidal modeling in sea-level reconstruction. Second, we offer examples of research problems that can be addressed with this sea-level database, several of which revolve around the identification of crustal motions due to glacial forebulge collapse that affects the entire region and likely extends beyond South Florida. Among others, we show that rates of vertical crustal movements from Holocene RSL data can be constrained with a resolution that is almost an order of magnitude better than with currently available geodetic data. Finally, we show that this sea-level database enables a more refined interpretation of tide-gauge records along the Atlantic Coast, potentially including the fingerprinting of meltwater sources.

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**INFLUENCE OF SUBMARINE GROUNDWATER DISCHARGE ON THE CHEMICAL AND ECOLOGICAL COMPOSITION OF COASTAL WATERS OF A MEDITERRANEAN ISLAND (MAJORCA, SPAIN)**

Despite the importance of submarine groundwater discharge (SGD) delivering freshwater and dissolved substances to the coastal ocean, there is limited information on its effects on the biogeochemical processes in the coast. This work evaluates the ecological relevance of submarine groundwater discharge (SGD) to coastal waters of Majorca Island (NW Mediterranean). We chemically characterized the components that are diffusely supplied to the coastal water through this pathway and evaluated its effects on phytoplankton biomass and microbial communities. During April 2010, a survey of SGD to the coast (estimated from 224Ra, 223Ra and salinity measurements) was conducted in 47 sites around the island. Measurements of dissolved nutrients (C, P and N) and trace metals (Ag, Cd, Co, Cu, Fe, Mo, Ni, Pb, V and Zn) were performed in order to characterize the elements delivered to the coastal environment. SGD in different bays were characterized using piezometers and the effects of submarine groundwater on the native plankton populations of the coastal area were examined through a series of in situ groundwater addition experiments. Results indicate that, with some variations indebted to aquifer characteristics, SGD to coastal waters is significant and widespread around the island. SGD influences the generally low dissolved coastal ambient nutrient and trace elements (mainly NO3- and Fe) and enhances nearshore phytoplankton biomass. Effect of diffusive SGD on the nearshore is intensified in Palma Bay where intensive agricultural practices, including the use of treated urban wastewater irrigation and aquifer recharge, and the influence of adjacent eutrophied wetland have altered the nutrient and trace metals concentrations in groundwaters. Groundwater nutrient enrichment, either low-impacted or influenced by human activities, can effectively stimulate autotrophic plankton growth, thereby producing shifts in the microbial food-web structure of coastal waters.

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**THE INDIAN RIVER LAGOON: TRANSITION FROM HOLOCENE TO ANTHROPOCENE**

The millennia-old sandy bottom, clear water and vibrant ecosystem of the Indian River Lagoon all have been altered in many areas by accelerated inputs of freshwater, soil, nutrients and contaminants during the past 5-6 decades. Pockets of fine-grained, organic-rich sediment (a.k.a. “muck”) as thick as 2.4 m are found in the Intracoastal Waterway, lesser navigational channels and causeway borrow pits. Management decisions to dredge and create spills in several adjacent creeks have lessened the potential for further additions of soil and muck to the open lagoon. Nonetheless, a 67% increase in the thickness of existing muck deposits was observed between 1989 and 2006. Although muddy deposits cover <10% of the lagoon bottom, their impact appears to be more widespread. Direct links between muddy areas and altered benthic ecosystems, increased turbidity and increased light limitation in the lagoon have been observed. Increases in concentrations of suspended sediments have been linked to declines in seagrass abundance. Using results from age-dated sediment cores, the onset of anthropogenic inputs of heavy metals (Ag, Cd, Cu, Hg, Pb and Zn), as noted by higher metal/AI ratios, occurred during the 1950s. Highest concentrations of Ag and Pb date to the 1960s and 1970s whereas the Cu/AI ratio for sediments has increased gradually since the 1960s. Present-day concentrations of most metals in the clam Mercenaria mercenaria have remained within ±20% of values observed in 1992; however, a dramatic decline in the clam population was found during a recent survey. This decline is yet another indication of human-induced change in the lagoon, albeit not necessarily linked to muck or heavy metals. Overall, several indicators suggest that a transition from the Holocene to the Anthropocene is occurring in the Indian River Lagoon and that many protective management decisions and actions are needed to slow or reverse this transition.
that canal filling will increase the use of alligator ponds and similar habitats as dry-season refuges for fish, recapturing their historical ecosystem function that has been diminished with the addition of canals. If canal refuge area is reduced, marsh operations will become increasingly critical to maintaining populations of long-lived fishes such as bass in the Everglades. Using simulations, we conclude that decompartmentalization need not decrease current populations of largemouth bass in the Everglades, particularly if operations successfully mimic historical patterns and frequency of drying in the marshes.

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INTEGRATING MULTIPLE WATER QUALITY MONITORING TECHNIQUES FOR ECOSYSTEM ASSESSMENTS IN CHESapeake BAY, MD

The Maryland Department of Natural Resources (DNR) has operated a spatially and temporally intensive water quality monitoring network since 2003 to assess EPA mandated water quality criteria. The Maryland network, comprised of 40 or more continuous monitors and surface mapping of tributaries, produces millions of data records each year. It supplements the Chesapeake Bay fixed monitoring station network that has been sampled monthly/bi-monthly for the past 26 years. Integrating these measurements of differing spatial and temporal resolution to produce a holistic view of water and habitat quality presents unique challenges. We will discuss recent efforts by DNR and its Chesapeake Bay Program partners to address these challenges in several assessment methodologies. A spatial water clarity model used to determine areas of acceptable SAV habitat was developed using a combination of continuous monitoring, in situ data collection, and intensively mapped data. Another technique, known as spectral casting, uses high frequency data collected by near-shore continuous monitors to enhance mid-channel data collected at lower frequencies. Spectral casting involves modeling a synthetic dataset that incorporates the variation of high-frequency data while maintaining the long-term trajectory of low-frequency data. Finally, we will present a recent redesign and future plans for our public water quality website, Eyes on the Bay (www.eyesonthbay.net), which serves as a data exploration and visualization tool for various water quality datasets.

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CALCULATING WATERSHED NITROGEN LOADING REDUCTIONS NEEDED TO COMPLY WITH NUMERIC NUTRIENT CRITERIA FOR THE GREAT BAY ESTUARY, NEW HAMPshire AND MAINE, USA

In 2009, the New Hampshire Department of Environmental Services (DES) published a proposal for numeric nutrient criteria for the Great Bay Estuary. The report found that total nitrogen concentrations in most of the estuary needed to be less than 0.3 mg N/L to prevent loss of eelgrass habitat and less than 0.45 mg N/L to prevent occurrences of low dissolved oxygen. Based on these criteria and an analysis of all available data, DES concluded that 11 of the 18 subestuaries in the Great Bay Estuary were impaired for nitrogen. Under the Clean Water Act, if a water body is determined to be impaired, a study must be completed to determine the existing loads of the pollutant and the load reductions that would be needed to meet the water quality standard. Therefore, DES developed simple estuarine mixing models to determine the watershed nitrogen loading thresholds for the subestuaries to comply with the numeric nutrient criteria. DES also evaluated the effects of different permitting scenarios for wastewater treatment facilities on delivered nitrogen loads, non-point source load reduction requirements, and the costs for wastewater treatment facility upgrades. This modeling exercise showed that: (1) Nitrogen loads to the Great Bay, Little Bay, and the Upper Piscataqua River need to be reduced by 30 to 45 percent to attain the numeric nutrient criteria; (2) Both wastewater treatment facilities and non-point sources will need to reduce nitrogen loads to attain the numeric nutrient criteria; (3) The percent reduction targets for nitrogen loads only change minimally between wet and dry years; and (4) The average cost per pound of nitrogen removed from the estuary due to wastewater facility upgrades is lower than for non-point source controls. The simple models developed for this analysis can be applied to other estuaries and offer a way to convert between ambient concentration-based criteria and watershed load-based criteria.
Water management and climate change interactions in the Everglades coastal ecotone have resulted in widespread changes, including hypersalinity, marine transgression, reduced macrophyte productivity, and expansion of degraded habitat known as the "white zone". These changes are largely attributed to changes in salinity patterns. Taylor Slough and C-111 watershed will be the site of significant hydrological changes as a result of the C-111 Spreader Canal Western Project, a primary restoration action aimed at improving freshwater inflow to the Taylor Slough watershed. To understand how changes in quantity, timing and quality of water deliveries will affect downstream wetlands and estuaries, we are measuring nutrient, hydrologic and biological parameters in a spatially extensive network of sites throughout the C-111 Spreader Canal Project footprint encompassing the Model Lands, C-111 Basin and Lower Taylor Slough. New features of this monitoring and other ongoing research include spatio-temporal dynamics of surface and soil water salinity patterns through the ecotone and water quality of creeks discharging into Florida Bay west of Taylor Slough.

Key results of this work illustrate the extensive coupling between watershed hydrology and salinity patterns in the Everglades coastal ecotone. For example, landscape patterns in soil solution specific conductivity can be differentiated between Taylor Slough and C-111 watersheds and across seasons at 15cm soil depth. In early dry and wet seasons, specific conductivity patterns suggest greater upstream freshwater influence in ecotonal wetlands south of the C-111 Basin. In the early wet season, increased hydrologic head appears to contribute to decreased specific conductivity values in ecotonal wetlands south of the Taylor Slough watershed that remain higher than in soils of wetlands south of C-111. These and other key findings will be presented in the context of facilitating management.

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**NUTRIENT CYCLING AND DENITRIFICATION IN SEDIMENTS OF MANGROVE ESTUARIES ON THE PACIFIC COAST OF PANAMA**

Mangrove estuaries on the Pacific coast of Panama receive variable land-derived inputs related to the degree of human use of the watershed. We have been studying several such estuaries in a relatively undeveloped area in the Veraguas Province, one of the few remaining areas where some of the watersheds remain fully forested. The estuaries we study have watersheds that span a range of deforestation from 0 to 85%, and some contain villages. The downstream reaches of these estuaries are fringed with well-developed mangrove forests dominated by Rhizophora mangle but also containing the endemic species Pelliciera rhizophorae. Our goal was to study nutrient cycling in the mangrove sediments of estuaries representing high and low degrees of human impact. We selected two pairs of estuaries, each containing one heavily forested watershed and the other containing villages and a high percentage of land cleared (by burning) for small-scale agriculture or cattle grazing. Samples were collected at the end of the dry and wet seasons (Mar-Apr and Nov-Dec, respectively). Intact cores were taken at two intertidal sites within each estuary, one near the mouth of the estuary and one near the upstream extent of the mangroves. Cores were incubated at ambient temperature, in the dark, and with tidal water of salinity selected to match water that would cover the sediments at high tide. Data from the first year of sampling (2010) showed surprisingly little seasonal or site differences in sediment metabolism or denitrification. Rates of oxygen uptake were substantial, ranging from 28-65 mmol m⁻² d⁻¹. Denitrification rates (based on N₂/Ar) were among the higher reported for mangrove systems, ranging from 1.4 to 4.1 mmol N m⁻² d⁻¹. Nutrient fluxes were highly variable. Additional measurements of nitrogen fixation, potential denitrification, and DNRA, as well as a comparison of denitrification rates using N₂/Ar and the isotope pairing technique will be discussed.

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**THE BONNEAU FERRY RESTORATION PROJECT (BFRP): RETURNING A SUCCESION STAGE 2/3 FORMER FRESHWATER TIDAL RICE FIELD TO SUCCESION STAGE 1**

Freshwater tidal zone former rice fields in coastal South Carolina exist today in two water control states: 1. intact dikes with water level control and 2. breached dikes without water level control, subject to daily tidal exchange. Breached fields occur in 1 of 5 depth dependent succession stages ranging from stage 1 subtidal, dominated by submerged aquatic vegetation (SAV) to stage 5 intertidal, dominated by closed canopy swamp forest. Stage 3, intertidal with emergent marsh predominates statewide and stage 1 is the rarest with only 6 remaining fields in SC, all on the Cooper River. One stage 1 field on the Cooper River, Mulberry, has been observed to contribute several ecosystem services to the drainage basin, including dissolved oxygen export, nitrate, phosphate and BOD uptake, abundant and diverse invertebrate populations, heavy bird and fish use and is a preferred destination for recreational boaters. The goal of the BFRP is to test the possibility of creating conditions similar to the stage 1 Mulberry field at a 16.2 ha site at Bonneau Ferry Plantation on the east branch of the Cooper River. The plan will establish water level control, re-contour the interior to support SAV, maximize tidal exchange with the river and emulate Mulberry in its invertebrate, fish and bird populations and water quality attributes. The novel design, self-regulating water control structure will allow public boat access and maintain water level control. Approximately 1/3 of the SA V systems on the Cooper River have been lost to later successional stages following water level drops resulting from the Cooper River Rediversion Project in 1985. A successful BFRP will demonstrate the feasibility of returning advanced stage fields to stage 1, preserving a singularly valuable habitat type.

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**NOAA ECOLOGICAL FORECASTS: EMERGING TOOLS FOR COASTAL RESOURCE MANAGERS**

The National Oceanic and Atmospheric Administration (NOAA) is well known for its weather forecasts, water level forecasts and climate predictions. It also delivers biological forecasts associated with fish stock assessments for fisheries management. Until recently these forecasts were provided within one scientific discipline (e.g., atmospheric science, hydrology, fisheries or climatology). More recently NOAA has produced “ecological forecasts” that make use of a wide range of information and link several different disciplines. Some of these forecasts have been or are in the process of being transitioned from research to operations or application at the national or state level. Others are still in various stages of development. The forecasts produced include scenario-based predictions (e.g., habitat restoration success), near real-time forecasts (e.g., Gulf of Mexico harmful algal blooms, Chesapeake Bay jellyfish and pathogens, and trajectories and impacts of oil spills and pollutants), and long-term projections for coastal ecosystems (e.g., ecological impacts of sea level rise on coastal habitats, and the extent and impacts of hypoxia). We will present various examples of these forecasts and discuss the methods used to transfer them to appropriate management communities. We seek to interact with community leaders and regional managers at theaster session to gather input on how these products and ecological forecasts in general can be made more useful to regional issues and priorities.

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**MODELING CLIMATE CHANGE EFFECTS OF NUTRIENT DYNAMICS IN THE GUADALUPE ESTUARY**

Changes in precipitation associated with climate variability influence the export of water and water-borne materials from land to sea. In turn, changes in land-sea export have important consequences for estuarine ecosystems. This study considers the potential influence of variations in nitrogen export from the Guadalupe River Basin (GRB) and San Antonio River Basin (SARB) to the Guadalupe Estuary between 1990 and 2009. Empirically-derived estimates of nitrogen export from the GRB and SARB have been coupled with a simple model that describes the relationships between nitrogen, phytoplankton, and zooplankton communities (i.e. an NPZ model) in the estuary to explore how variations in nitrogen loading over daily to decadal time scales influences the estuarine ecosystem. While this analysis considers contemporary variability in nitrogen loading, the results are being used to consider how future changes in regional precipitation (and associated nitrogen loads) will influence estuarine ecosystems of south Texas.
A sustainable society will be more than a random collection of individuals in a shared space. To succeed it must have shared values arising from an appreciation of the uncertainties, truthfulness and thorough assessments (science?), and abilities to implement decisions. There is a sense of urgency because society is bounded by contrary sets of habitual behaviors, and the natural laws of systems will not be suspended while we think/argue about how to reach our goals. And so we must observe the “First Rule of Holes” which is: when one is in a hole, stop digging…and change behaviors – a tough task. But to do this we need to know the details and, importantly, the experience of change. Bismarck was wrong about what we need to know about making good-tasting sausages, like politics, because we do, indeed, need to also know what goes into sausages and how they are made. Even if a sustainable system could be designed by a well-intentioned elite, an unacceptable design will not be implemented by the whole without an unfriendly set of maintenance costs. Designs for a benign sustainability must be accepted by all of society to work, or else undesirable influences will superecede our abilities to influence outcomes (e.g., climate change). If we are to find a prosperous way out of the conundrums, then it will include at least four attributes: 1) a social contract between society and natural systems, 2) an ethical framework that encompasses compassion at the group level, 3) shared governance (fairness), and 4) a socially structured appreciation of ignorance. These themes will be explored using examples from coastal wetland restoration. It is not clear, at all, that this can be accomplished soon enough, but it will be greatly helped if there are experiments matching the scale of the problem(s).

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LANDSCAPE-SCALE PATTERNS OF TROPICAL CYCLONE SEDIMENTATION IN THE NORTHERN GULF OF MEXICO

Hurricanes Katrina, Rita, Gustav, and Ike deposited large quantities of sediment on coastal wetlands after making landfall. Various spatial interpolation methods were used to model the inorganic sediment deposition from each storm. The sediment deposition on coastal wetlands was an estimated 67 million metric tons (MMT) from hurricane Katrina, 50 MMT from hurricane Rita, and 21 MMT from hurricane Gustav. The spatial distribution of sedimentation within each storm event was also analyzed. Deposition reflected storm surge intensity, and decreased with distance from storm track and distance from the coast. Preliminary results indicate that there is a similar decay relationship to distance from the coast for all three storms, but that the relationship with distance to track is more variable. The land-to-water ratios varied within each depositional area, but did not appear to have an effect on the landscape-scale distribution of sediments. These results highlight an important link between tropical cyclone events and coastal wetland sedimentation, and are useful in understanding sediment budgets for coastal wetlands.

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SEDIMENT AND NUTRIENT TRADEOFFS IN RESTORING MISSISSIPPI RIVER DELTA

Delta restoration is a generic environmental problem worldwide in which human and natural dynamics are strongly and inherently coupled. The urgent need for wetland restoration and rehabilitation at large spatial scales has been addressed through the diversion of riverine water from the Mississippi River. The conflict to resolve ecosystem needs of river and coastal processes to sustain the delta with demand for structural features from levees and floodgates to protect people and infrastructure has always historically favored investments in resiliency of the social system at the expense of the natural system. The challenge to develop bold new ideas of river management to reintroduce sediment to the coast are further complicated by how the chemistry of the river has changed over the last four decades. Because of large nitrogen loading through the Mississippi River basin, there is increasing coastal eutrophication and the development of a large hypoxia zone (up to 21,000 km2). As more freshwater diversion projects are planned along major waterways throughout the state of Louisiana, there is concern that this new constituent of nitrate will contribute to reduced water quality conditions of shallow bays and estuaries of the delta. Concerns about creating large human health risks as result of toxic algal blooms induced by increasing nitrogen inputs, underscore the difficulty of implementing large-scale restoration plans in coastal regions. This juxtaposition of protection, wetland restoration, and eutrophication, all linked to bold new approaches to river basin management. Managing all these competing tradeoffs to sustain the economic and natural resources of this region are representative of how we must consider new approaches to watershed – coastal catchments throughout the world.

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DOES THE HARDSHELL CLAM, MERCENARIA MERCENARIA, INFLUENCE NITROGEN REMOVAL IN EUTROPHIC SHALLOW ESTUARIES?

The hardshell clam, Mercenaria mercenaria is a cosmopolitan inhabitant of Western Atlantic estuaries, with ecological and economic importance. Prior work in deep estuaries has shown a resistance to hypoxia, however, little is known about its resistance to macroalgal blooms that occur in eutrophic shallow estuaries or about the effect of this species on key nitrogen removal processes. Using both field and laboratory microcosm experiments, we investigated these relationships in West Falmouth Harbor, Massachusetts, USA, a shallow estuary currently undergoing rapid eutrophication. The harbor has distinct sub-basins, one with muddy, highly organic sediments and dense summer macroalgal blooms and another sandy sub-basin lacking opportunistic algae. Growth of M. mercenaria was significantly greater in the muddy inner harbor and showed no negative effects of moderate macroalgal cover in either basin. Further, in both basins, bioturbation by clams lead to significant reduction in porewater ammonium and sulfide suggesting sediment oxidation and enhanced mineralization; this did not, however, lead to a measurable influence on sediment-water column fluxes of dissolved inorganic nitrogen. Daily sediment oxygen consumption and nitrogen removal through denitrification were higher in the presence of clams in muddy sediments only. These results suggest that the effect of M. mercenaria on overall ecosystem metabolism and nitrogen removal is habitat specific. Further, in reaches of estuaries prone to eutrophication, M. mercenaria can persist even in the presence of moderate macroalgal cover and may have a buffering effect on the progression of eutrophication through the removal of reactive nitrogen.

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ALTERNATIVE NITRATE REDUCTION PATHWAYS IN EXPERIMENTALLY FERTILIZED NEW ENGLAND SALT MARSHES - REMOVAL VERSUS RECYCLING OF BIOLOGICALLY AVAILABLE N

Nitrate present or generated in any benthic ecosystem can be reduced by a number of microbial pathways, most notably denitrification, anaerobic ammonium oxidation (anammox) and dissimilatory nitrate reduction to ammonium (DNRA). The first two processes remove of biologically available N from the ecosystem in the form of gaseous N2, while the last process transforms of NO3- to another biologically available form, NH4+, and thus merely recycles N. Salt marshes are important ecosystems for the cycling, retention and removal of biologically available N transported from land to the oceans. We used ongoing ecosystem level nutrient additions experiments in two New England salt marshes, Plum Island Sound (NO3- additions since 2003) and Great Sippewissett Marsh (fertilizer additions since the 1970s) to examine the relative importance of these NO3- reduction pathways in salt marshes. Sediments from several experimental (and unmanipulated) sites were collected during the late summer/fall of 2009 and summer 2010 to measure the potential rates of NO3- reduction in sediment slurries enriched with NO3- and 15NO3- added as a tracer. The resulting 15N-labeled products (30N2, 29N2 and 15NH4+) were analyzed by mass spectrometry to determine rates of denitrification, anammox and DNRA, respectively. Sediment and plant parameters were also assessed for each site. Potential denitrification rates were high during mid-summer (up to 30 nmol N gww-1 h-1) but low during late summer and fall (< 5 nmol N gww-1 h-1). DNRA rates were both seasonally and spatially variable but was the dominant reduction pathway when denitrification was low suggesting a shift in importance between these two processes. This shift was loosely related to increasing NO3- loadings in Plum Island Sound, but showed the opposite trend in relation to N loading in Sippewissett. Clearly more work is needed to understand what determines the relative importance of removal versus recycling processes in salt marsh ecosystems.
Valley Estuary, is more applicable. At the WWL level, the River/Stream Subform is the only Current Hydroform applicable to the study area, but it only describes the prevailing current during an ebb tide. The greatest strength of CMECS is the comprehensive set of modifiers, which are physico-chemical, physical, spatial, geological, biological, anthropogenic, and biogeographic variables with defined categorical values. Overall, the classification standard CMECS contained the essential classifiers needed to characterize the physical environment at the study sites.

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IMPACTS OF INTENSE FISHING PRESSURE ON COMMUNITY-LEVEL TROPHIC CASCADES: AN ASSESSMENT USING NO-TAKE AND FISHED REEFS THROUGHOUT THE FLORIDA KEYS NATIONAL MARINE SANCTUARY

The negative impacts of man’s removal of large predators on food web structure and the resulting changes in the intensity and direction of trophic interactions are now a virtual paradigm of marine ecology. Using comparisons of food web structure and estimates of trophic transfer from fished and unfished back reefs in two widely separated regions of the Florida Keys National Marine Sanctuary, we found that the magnitude of protection impacts vary significantly with region. While fishing cessation led to elevated exploited species density in most unfished reefs, we found no evidence that exploited species impacted the density, or feeding rates of herbivores or invertivores. Why these results contrast the existing paradigm is uncertain, but we noted that the majority of the exploited fishes were omnivores, not piscivores. We also noted that piscivores were dominated by transient, unexploited species such as bar jacks and barracudas, and not commercially harvested species. These results call into question current thinking about the prevalence of community-wide trophic cascades in tropical ecosystems. Our results show that the impacts of restoring exploited species are likely to be less, and to vary more, that current thinking suggests.

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RELATIVE INFLUENCE OF CORIOLIS AND ADVECTIVE ACCELERATIONS IN A COASTAL PLAIN ESTUARY

Underway measurements of current velocity and water density profiles were obtained at a cross-section in the central regime of a coastal plain estuary with the purpose of comparing the effects of advective to Coriolis accelerations on tidal and residual dynamics. Data were collected throughout neap and spring semidiurnal tidal cycles during moderate-to-high river discharge of the James River, Virginia, USA. Tidal flows exhibited typical cross-estuary gradients of velocity and temperature. The greatest strength of CMECS is the comprehensive set of modifiers, so that implications of human interference (like dredging operations or land reclamations) or long-term developments related to climate change (like sea level rise or changing river regimes) can be assessed. The objective of the current research is to hindcast and forecast decadal morphodynamic developments in San Pablo Bay, California, USA. Experience gained in the hindcast is used to model a forecast future morphodynamic changes in San Pablo Bay. In the 19th century more than 250 million cubic meters of sediment deposited in San Pablo Bay because of hydraulic gold mining activities. When mining stopped and dam construction was carried out, San Pablo Bay showed an eroding trend. Focus of the hindcast is on the 1856-1887 depositional period and on the 1951-1983 erosional period. Model outcomes are evaluated against measured bathymetric developments [Cappiella (1999); Jaffe et al (2007)] and include an extensive sensitivity analysis on model parameter settings. Predictions will be made for 30 years starting from the 1983 bed. The results show that applying best-guess model parameter settings can predict decadal morphodynamic developments reasonably well in San Pablo Bay. Modeling the erosional period is more sensitive to bed composition data. The forecast gives insights into morphodynamic developments that can be expected coming decades. Results are not presented in a deterministic way, but rather in likely developments including uncertainty bands.

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A META POPULATION DISTRIBUTION OF THALASSIA TESTUDINUM IN THE CARIBBEAN AND GULF OF MEXICO

The seagrass Thalassia testudinum is widely distributed throughout tropical and subtropical western Atlantic. Capable of long distance dispersal (LDD), previous studies in the Mexican Caribbean have shown a significant relationship between geographic isolation and genetic differentiation indicating that propagules are effectively dispersed over large distances (>100km). In this study we evaluate the population genetic structure and genetic connectivity of T. testudinum across its biogeographical range, covering >4000km. Using a population network approach a clear metapopulation distribution over the total range is observed. Metapopulation model applies to interpreting the pattern of pairwise population differentiation; some geographically isolated populations are genetic similar while other populations that are within potential dispersal distance are highly differentiated. This also reflects the opportunistic nature of Thalassia’s dispersal strategy. A Bayesian assignment approach revealed the presence of three bioregions that correspond to the Gulf of Mexico, North Eastern Caribbean and Central Caribbean. Three populations in the centre of the species range and Bermuda exhibited shared region membership an indication of the absence of stern barriers and possibly a transition zone between the genetically determined biogeographic regions. Clonality was observed in the majority of populations indicating it exists as a dominant meadow maintenance strategy, although sexual reproduction was equally important when averaged over all populations.

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SEDMENTS AS A SOURCE OF CHEMICALS FOR THE MARINE ENVIRONMENT? A CASE STUDY FOR THE NETHERLANDS COASTAL WATERS

The implementation of the European Union’s Water Framework Directive (WFD) is now at a stage where the necessary measures are being prepared to achieve the required improvements of the water quality. A study has been conducted for selected chemicals, supported by mathematical modelling, aiming at establishing the effectiveness of the planned emission reduction measures to achieve the relevant water quality targets in the Dutch coastal waters in 2015 and 2027. During this study, the role of sediment as a source of chemicals for the marine environment needed to be elaborated quantitatively, especially in a situation where the emissions show a strong temporal trend. The study consisted of different parts: (i) data collection, (ii) model set-up and validation, and (iii) diagnosis and prognosis, supported by mathematical modelling. Key data sets proved to be the emission database for the national waters, as well as the marine sediment sampling data collected via the national water quality monitoring programme. The model set-up relied on existing hydrodynamics and fine particles transport models for the southern North Sea. Due to the representation of seasonal sediment buffering in the latter, the present model for chemicals is able to take into account the accumulation and release of chemicals from the marine sediments. After a successful validation, the model was used to diagnose the 2005 situation and provide a prognosis up to 2027, for cadmium, copper, zinc, tributyltin and five polycyclic aromatic hydrocarbons (PAHs). The prognosis resulted in a clear insight in the expected effectiveness of planned emission reduction measures for the nine analysed chemicals. For TBT, the marine sediments showed a release of previously accumulated TBT following the recent ban on TBT-based anti-fouling coatings. However, the measures are expected to be effective to achieve the WFD targets by 2015, even if the role of buffering marine sediments is taken into account.
POTENTIAL Flotte FIELD EFFECTS OF TIDAL ENERGY EXTRACTION ON INTERTIDAL ECOSYSTEMS OF THE BAY OF FUNDY

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The measurement of Net Ecosystem Production (NetPP) is the difference between primary production and Community Respiration, which is a direct indicator of trophic status and health of an ecosystem. While these competing processes tend to influence the activity of one another, they are not always closely coupled. Ecosystems can become net autotrophic (NetPP > RESP) or net heterotrophic (NetPP < RESP) based on plankton community composition, as well as the quantity and quality of available nutrient sources and photosynthetically active radiation (PAR). The Mississippi coastal estuarine system is characterized by extensive fluvial input, terrestrial runoff, and high benthic sediment fluxes, resulting in the delivery of both inorganic and organic substrates to fuel biological activity. In addition, incident solar radiation and inherent optical properties of the water column vary drastically on both spatial and temporal scales, directly affecting the attenuation of light (kd) and the distribution of ecosystem productivity. In this study, in-situ incubations of natural seawater in the Mississippi Sound were monitored for changes in dissolved oxygen concentrations over time to derive rate measurements of NetPP and RESP. The derivation of biological rates using optical DO sensors (optode technology) allowed us to measure ecological processes on very short time scales (minutes) to assess diet and seasonal changes in NetPP and RESP. The Mississippi Sound represents an estuarine coastal ecosystem strongly influenced by land and the atmosphere. Here we demonstrate how hydrography and incident solar radiation may determine ecosystem metabolism in this estuary.

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STABLE-ISOTOPE ANALYSES REVEAL THE IMPORTANCE OF SEAGRASS BEDS AS FEEDING AREAS FOR JUVENILE MYROPHYS PUNCTATUS (ANGUILLIFORMES: OPHICHTHIDIAE) RECRUITING IN THE COASTAL WATERS OF FLORIDA

The feeding habits and habitats of the speckled worm eel Myrophys punctatus were studied on the mangrove edge of the Indian River Lagoon (IRL, Florida) using gut-content and stable isotope analyses of carbon and nitrogen. Four taxa were identified through dietary analyses of gut contents and the index of relative importance suggested that amphipods, microphytobenthos and annelids are the most important food sources in the eel’s diet. To assess the feeding habits of the eels after their recruitment to coastal waters of the IRL, these food sources were collected in mangroves and nearby seagrass beds for isotope analyses. Stable isotopes constituted a powerful tool for discriminating fish prey items from mangroves (δ13Cmean = -20.5±0.6‰) and those from seagrass beds (δ13Cmean = -16.9±0.6‰), thus providing good evidence of food-source origins. The 56 eels collected (10.9 < LT < 16.2 cm) had average isotopic signatures of -16.7±0.2‰ in δ13C and 2.0±1‰ in δ15N. A significant depletion in 13C was observed for larger juveniles (15.0 < LT < 16.2 cm), suggesting that they found a portion of their food in mangroves. Estimation of the trophic level from stable isotopes (TLiso) was similar among different size groups of juvenile eels (TLiso = 3.2 to 3.5); therefore Myrophys punctatus was considered a secondary consumer, which is consistent with its zoobenthic diet. The concentration-dependent mixing model SIAR revealed the importance of food sources from seagrass beds as carbon sources for all the eels collected, with a significant increase of mangrove prey contributions, such as annelids, in the diet of larger juveniles. This study highlights the importance of seagrass beds as feeding habitats for juveniles of Myrophys punctatus after their recruitment to coastal waters.

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CHANGES OVER TIME IN THE CHARACTERISTICS OF THE FISH FAUNAS OF A LARGE, MICROTIDAL ESTUARY FOLLOWING MAJOR MODIFICATIONS

The Peel-Harvey Estuary in south-western Australia became so eutrophic in the 1970s to 1980s that a large, artificial entrance channel was opened in 1994 to increase tidal exchange between the estuary and the ocean and thus flush nutrients out of the estuary. The increased influx of saltwater led to the salinity within the estuary remaining at higher levels during winter and spring when freshwater discharge is greatest. The characteristics of the fish assemblages in 2008–10 were determined and compared with those recorded previously in 1980–81 and 1996–97 to explore the extent to which the fish fauna has changed over the last three decades in response to anthropogenic and other influences. The reduced heterogeneity in environmental conditions within the main body of the estuary and greater tidal exchange with the ocean accounts for the ichthyofaunal composition now undergoing greater seasonal changes and to be less related to region within the estuary. Although the composition of the fish fauna in 2008–10 was similar to that in 1996–97 than in 1980–81, there were indications that it was reverting back towards that of the earlier period. Furthermore, the overall densities of fish in the estuary declined significantly after the opening of the artificial channel (1990s), but rose markedly in 2008–10, which also suggests that conditions in the estuary may be returning to those of the 1980s. This view is consistent with the fact that the estuary was driven, to a certain extent, by those of the densities of two macrophyte-associated species, Apogon rueppelli and Pelates octolineatus which were very abundant in the early years when macroalgae were very abundant and are now abundant again. However, the fish faunas of 1996–97 and 2008–10 were characterised by the presence of very high densities of the marine species Torquigener pleurogramma, presumably reflecting a greater accessibility of the estuary to this marine species.
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TIDAL MARSHES IN THE DELAWARE ESTUARY: HISTORICAL RECONSTRUCTION OF CHEMICAL LOADINGS

Tidal marshes are among the most productive ecosystems in the world. They serve as regional sinks for fine-grained sediments and organic carbon, and contribute to the seasonal patterns of turbidity in riverine and coastal waters. Because of their ability to adsorb trace metals and organics, fine-grained sediments represent a major repository for contaminants. They are a record of the temporal changes in water quality and can be used in historic ecological reconstructions. During the early 20th century, there was a substantial loading of chemical contaminants, such as PCBs, PAHs and DDT throughout the Delaware estuary.

Since the mid-to-late 1980s, inputs of various “emerging” chemicals, e.g., PBDEs, have also increased. However, since the early 1960s, there have been efforts to reduce chemical loadings, improve ecological conditions within the estuary and reduce the concentration of contaminants in fish. Sediment cores were taken from ~30 tidal freshwater and estuarine marshes in the Delaware Estuary to estimate historic loadings of chemical contaminants, nutrients and their potential ecosystem impacts. Chronologies were determined with 210Pb and 137Cs isotopes. A preliminary analysis suggests an average sediment accumulation rate of 0.62 and 137Cs isotopes. A preliminary analysis suggests an average sediment accumulation rate (210Pb) of 0.62 ± 0.24 cm/yr (12% RSD; n = 22) with a range of 0.22 to 1.3 cm/yr.

Sediment-bound PCBs and other organic contaminants increased in concentration starting in the late 1930s to mid-1950s. Many organic contaminants showed peak concentrations in the 1960s to 1970s. There were also river basin specific differences in contaminant concentrations presumably related to changes in watershed land use with contaminant inventories highest in more urban watersheds. The benefits of coral and developing accurate sediment contaminant chronologies are key to reconstructing historic anthropogenic impacts on the environment. This information will be used to evaluate current environmental conditions and guide future restoration efforts.

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A TECHNIQUE FOR MONITORING SALT MARSH SUBHABITATS: INTEGRATION OF QUICKBIRD SATELLITE IMAGERY WITH GIS TO MAP SUBZONES IN A VIRGINIA SALT MARSH

Mapping coastal marshes using remote sensing techniques provides a means of monitoring large coastal areas with a greater frequency than is possible using ground surveys. We compared high resolution Quickbird imagery to ground-based plant survey data (transects every meter on a 50 X 50 meter plot) collected in a salt marsh near Wallops Island, VA, to determine the ability to detect small changes in vegetation within low marsh and high marsh areas. An infrared false color image covering a large area of the marsh created from Quickbird imagery was pan sharpened to increase the resolution from 2.4 m/pixel to 0.6 m/pixel. When we then overlaid the three detailed hand-mapped plots of vegetation on the pan sharpened images, some of the subzones of the low marsh and high marsh were clearly identifiable. The patterns that clearly correlated with distinct subzones in the ground truthed plots were then used to identify and quantify similar subzones in the available imagery covering a much larger area of the salt marsh. GIS is the ideal platform with which to track and analyze aerial changes in the subzones related to changes in land use or to sea level rise. This method may provide a means of monitoring small scale changes in Wallops Island salt marsh subzones over time and provide a useful tool for wildlife managers in nearby coastal habitats.

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A MODEL FOR INTEGRATING UNDERGRADUATE RESEARCH INTO COURSE CONTENT ACROSS DISCIPLINES: SALT MARSH MAPPING AS A FOCUS FOR COURSES IN REMOTE SENSING, GIS, FIELD ZOOLOGY, MARINE ECOLOGY AND WETLANDS ECOLOGY

In 2009, we started a research project in the salt marshes in the Wallops Island National Wildlife Refuge, Wallops Island, VA, to relate small-scale variations in marsh habitat to sea level change. The first step of the project was to carefully map the vegetation in three 50 meter by 50 meter plots, chosen to represent the range of vegetation subzones in Virginia salt marshes that are related to small sea level differences. The primary goal of the project was to determine the resolution needed to detect those small scale differences using remote sensing techniques. To date, the data sets collected have been used in several different courses:

Geographic Information Systems (GIS), Remote Sensing, and Field Zoology. The class project in Remote Sensing led to an undergraduate senior research project comparing Quickbird imagery (effective resolution of 0.6 meters) to the maps of the three plots, then expanding the analysis to a much larger area of the salt marsh. The need to field check and ground truth the expanded image analysis now provides an opportunity for the project to be incorporated into field exercises this summer in courses in Wetlands Ecology and Marine Ecology. We believe that when students know that their research projects in a course are integral parts of a larger whole that it helps them see the applicability and importance of their work. Thus they become more engaged, enhancing the educational experience.

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IMPROVED COMMUNICATION THROUGH MAPPING: USING ARCGIS TO ITERATIVELY COMMUNICATE SPATIAL INFORMATION AND MODEL RESULTS

Geographic Information Systems (GIS) can yield powerful results when applied to marine spatial planning. In this talk, we illustrate how the Natural Capital Project (Nat Cap) communicates spatial information with our partners on the west coast of Vancouver Island and in Belize. The InVEST (Integrated Valuation of Ecosystem Services and Trade-offs) tool, built on an ArcGIS platform, can be utilized to answer questions at both global and local scales. InVEST is a scenario assessment tool that can explore how various management alternatives might affect the delivery of a suite of benefits that people get from marine and coastal environments. We developed the models to iteratively communicate and garner spatially explicit information from stakeholders. Through GIS, we can effectively represent locally relevant scenarios in our models and then communicate model results to partners and then back to stakeholders and policymakers. Nat Cap’s partnership with West Coast Aquatic on Vancouver Island and the Coastal Zone Management Authority and Institute in Belize, together with GIS tools, has allowed us to incorporate local knowledge from various stakeholders (e.g. indigenous peoples, community groups) into our modeling. We will demonstrate how GIS tools can visualize proposed changes to both Vancouver Island and Belize’s coastal and marine regions and the likely effects of those changes on nature’s ability to provide food, protection from coastal hazards, and other services. We will conclude with a discussion of challenges and successes in using GIS tools for marine spatial planning.

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THE EBB AND FLOOD OF SILICA IN A NEW ENGLAND SALT MARSH

Silica is an important, yet understudied nutrient in many ecosystems; it is especially crucial in salt marsh systems where it contributes to the structure of the marsh grasses as well as that of phytoplankton, specifically, benthic and pelagic diatoms. As the most abundant phytoplankton in temperate waters, diatoms provide the base of some of the world’s most productive and environmentally viable food webs. However, silica limitation in coastal waters is becoming an ever more prevalent consequence of anthropogenic nutrient loading, leading to alterations in the phytoplankton community including the out-competition of diatoms by less desirable flagellate blooms. This study seeks to understand the dynamics of dissolved (DSi) and biogenic silica (BSi) transport to and from the salt marsh at the Plum Island Estuary Long Term Ecological Research (PIE LTER) site and how it may be influenced by nutrient fertilization. High-resolution sampling in July 2010 showed no significant differences in silica concentrations in the fertilized and non-fertilized creeks, with dissolved silica (DSi) ranging from 0-107 μM and biogenic silica (BSi) ranging from 0-42 μM.

However, net export of DSi and import of BSi between the salt marsh and Plum Island Sound was observed, indicating that the marsh serves simultaneously as a source of DSi and a sink of BSi to and from the estuarine environment.
LEGACIES OF DITCHING AND DITCH-PLUGGING IN NEW ENGLAND SALT MARSHES: LONG-TERM EFFECTS ON HYDROLOGY, ELEVATION, AND SOIL CHARACTERISTICS

Anthropogenic impacts to New England salt marshes have altered hydrologic flows in various ways, but unintended consequences from these habitat modifications have received little attention. Created ditches (our ancestor’s legacy) have existed on salt marshes for decades, but the effects of these hydrologic alterations are only poorly understood. Ditch-plugging (our legacy) is a methodology used for salt marsh habitat enhancement and mosquito control, but the long-term effects from this management practice are unclear. We used natural tidal creeks and pools as controls to examine the effects resulting from ditching and plugging, respectively, on hydrology, sediment characteristics, and marsh surface elevation. Results indicated only slight differences in parameters sampled within habitat adjacent to created ditches compared with natural creeks, and we infer minor ecological impact after 70+ years. Significant differences in hydrology, sediment characteristics, and marsh surface elevation were observed in habitat adjacent to natural pools compared with ditch plug pools, and these structural differences appear to result in ecological dissimilarities in function between the two habitats as well. The results of our study are important for natural resource managers to consider when planning salt marsh restoration and enhancement projects. The long-term legacy of ditch-plug pools, especially as they pertain to changes in climate, may increase vulnerability to sea level rise and should not be undertaken without careful consideration.

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FORECASTING VEGETATION CHANGES IN COASTAL LOUISIANA: THE FUTURE WITHOUT ADDITIONAL ACTION

As part of the planning effort for coastal restoration by Louisiana’s Office of Coastal Protection and Restoration, we developed a vegetation model to forecast vegetation changes under several uncertainty scenarios over a 50 year period. Our model uses information on water-level and salinity forecasted by a hydrology model to predict changes in vegetation composition over time and applies the vegetation mask over a landscape forecasted by a morphology model. There is a feedback between these models at 20 year intervals. Our output is used by storm surge/storm damage and higher trophic level models to estimate the changes in ecosystem services derived from the coastal zone. Our vegetation model is based on analysis of the Coastwide Reference Monitoring System, presented by W. Broussard. Based on water level variability and salinity that occurred during a year, the model predicts what percentage of the existing vegetation types will die and which new vegetation type will establish. The results show how different assumptions with respect to sea-level rise, subsidence, storm frequency, rainfall, and river discharge affect the distribution of vegetation types over the coastal zone. The results also show in which parts of the coast changes occur if no additional coastal restoration actions are taken.

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OYSTER CRASSOSTREA VIRGINICA AS SENTINELS OF ECOSYSTEM HEALTH AND ENVIRONMENTAL PERTURBATION: A CASE STUDY IN THE CALOOSAHATCHEE ESTUARY, FLORIDA

Watershed development and water management practices have altered freshwater inflows and impacted salinity and water quality in SW Florida estuaries thereby affecting responses of valued ecosystem components such as oysters, Crassostrea virginica. Given their sessile, benthic, filter-feeding nature combined with their ecological importance, oysters make excellent sentinel organisms and their responses are currently being used in detecting how freshwater alterations in SW Florida estuaries are impacting marine organisms and as indicators of restoration success of the Comprehensive Everglades Restoration Plan. Disease susceptibility, spat recruitment, growth and survival and reproductive condition of oysters were assessed, seasonally and spatially in relation to salinity and freshwater input into the Caloosahatchee Estuary (CE). Spawning of oysters and larval recruitment in the CE occurs between May – Oct, a period that coincides with seasonal rainfall, regulatory freshwater releases, and watershed runoff resulting in reduced salinities. Lack of storage in the watershed allows very high volume fresh water discharges during the summer months resulting in flushing of larvae to downstream locations, where, during the drier winter months juvenile oysters are exposed to very high salinities and predation, which is unfavorable for their survival. Prevalence and intensity of Perkinsus marinus infections increased with increasing salinity, which may account for observed larval recruitment and adult survival trends. These results suggest that management actions such as small, periodic
freshwater releases for durations of less than 2 weeks would result in lower disease prevalence and intensity, and higher juvenile oyster survival. Limiting freshwater releases to < 4000 CFS during late summer months would also limit flushing of oyster larvae to downstream locations where substrate is limited and create a more favorable salinity regime for spat recruitment and survival.

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OFFSHORE WIND POWER POTENTIAL AND RISKS TO BIRDS AND WILDLIFE IN NORTH CAROLINA’S COASTAL WATERS

The harvest of offshore wind resources may offer a reliable and sustainable alternative to existing forms of commercial-scale energy production. Agencies permitting wind farms require evidence of acceptably low risk of injury to environmental resources like birds and other wildlife. No wind farm has been constructed in U.S. coastal waters; however, a recent spatially-explicit feasibility analysis suggests great potential for wind power development for the coastal waters of North Carolina. We conducted twice weekly bird and wildlife surveys for 12 months in eastern Pamlico Sound and 4 - 21 surveys at two sites on the coastal shelf in Owsley and Raleigh Bays. Bird densities were 12.9 Km-2 in the Sound and 5.0 Km-2 in the coastal ocean. Marine mammals had densities 40 times higher in the coastal ocean with far greater species richness. Sea turtles were similarly 35 times denser in the coastal ocean. Bird abundances declined with distance offshore in the coastal ocean out at least 60 Km, with a 70% reduction over a distance range of 10 - 40 Km, a region where iconic true pelagic seabirds were not yet observed at high density levels. The N.C. coastal ocean has wind capacity factors in excess of 35-40% for a 3.6 MW turbine and seems suitable for wind power development because of low bird densities, the taxon at most risk to spinning rotors. Ultimately bird behavioral observations are required beyond the flight altitudes and the reactions to a high bridge that we measured to complete necessary EIS components. Marine mammals and perhaps also sea turtles are sensitive to the noise associated with installation of turbine base structures; this may be an issue but should be less than seismic surveys and well drilling for oil and gas. As the demand for energy grows and the need for sustainable energy options becomes evident, offshore wind power holds promise among the suite of renewable choices within the U.S. energy portfolio.

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OIL, DISPERSANT, AND DISEASE: IMPACTS AND INTERACTION ON CORALS IN THE FLORIDA KEYS

Coral reef worldwide face a variety of stressors, many with potentially synergistic effects. Understanding the dynamics of these interactions, and their resulting impacts on coral health, is critical both for predicting coral reef responses to changing environmental conditions and for developing effective management strategies. While both temperature and nutrient stressors are known to influence coral disease and mortality, the recent Deepwater Horizon (DWH) catastrophe and subsequent application of dispersant highlighted the need to further understand the biological impacts of crude oil and dispersants in coral ecosystems. Using an ex situ factorial design, this study examined the effects and interactions of DWH oil, the dispersant Corexit 9500A, and black band disease (BBD) on the coral Montastraea faveolata. Variable susceptibility to BBD and dispersant was observed across coral populations from three different areas in the Florida Keys, but no pattern was observed in response to oil exposure. Dispersant and BBD exposures had greater effects on zooxanthellae density and chlorophyll content than oil exposure. In addition, dispersant had a significantly negative effect on BBD severity. This study demonstrates that variable susceptibility to disease and chemical stressors among M. faveolata populations in the Florida Keys may be linked to zooxanthellae quantity and quality. Both microarray-based gene expression profiling and coral mucus bacterial community profiling were used to determine changes in coral health resulting from the treatment stressors, and will be used to generate diagnostic tools for monitoring oil of dispersant exposure in the field. Ongoing work will identify specific genotype traits that may contribute to disease resistance or resilience following oil and dispersant exposures.

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SEASHORE MALLOWS AS AN ECOSYSTEM ENGINEER

Rising sea level increases soil salinity and flooding frequency directly impacting low-lying coastal farmlands. Once productivity for traditional crops diminishes, management will be required to transition those working lands back to native status. Seashore mallow, Knautiastruma pentacarpus, being developed as a biofuel crop to prolong economic value in such cases; however its potential as a management tool has not been acknowledged. This study examines the capacity of seashore mallow to facilitate establishment of desirable wetland species. We hypothesized that seashore mallow presence would enhance colonization of native vegetation, such as Spartina patens, by acting as a nurse crop and directing the evolution of soil properties through a transitional period creating a habitat at which desirable species have a competitive advantage over invasive species such as Phragmites. Four treatments were planted in June 2009 at an upland field site adjacent to a salt marsh. The control, S. patens, seashore mallow, and combined treatments were laid out in a complete randomized block design with replication. These were sampled for species richness, percent cover, and morphological traits of individuals throughout the 2010 and 2011 growing seasons. Soil was tested for nutrients, pH, CEC, salinity, chlorophyll, and organic matter. Preliminary results from the first year suggest that the presence of seashore mallow enhanced S. patens recruitment but did not significantly impact growth of established S. patens individuals. These observations could indicate that seashore mallow stems are trapping seeds or creating favorable microhabitats for seedlings, hence facilitating establishment of S. patens then followed by a shift to a competitive interaction among mature individuals. Second year results are being integrated as they are collected and our findings thus far suggest the potential for use of seashore mallow as a low-cost and efficient nurse crop in degraded agro-ecosystems.

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FERRY MONITORING TO EVALUATE THE INFLUENCES OF LARGE RIVER DISCHARGE AND COASTAL UPWELLING ON THE DELAWARE BAY MICROBIAL BIOGEOCHEMISTRY

The Delaware Estuary is a coastal plain basin in the Mid Atlantic Bight. Despite large nutrient inputs from the urban region, the biogeochemistry of the lower bay is controlled by large river discharges, tidal flux and coastal upwelling. High river discharge in the spring supports stratification sufficient to stimulate a phytoplankton bloom, but the isolated bottom waters remain cold and oxygen-rich. With lower river discharge through the rest of the year, stratification normally does not extend beyond the tidal cycle. Large discharges in the summer can stimulate temporary stratification, phytoplankton blooms and nutrient delivery to the lower bay. These periodic events probably also isolate bottom waters long enough for oxygen depletion to occur. Continental shelf waters adjacent to the Delaware Bay experience regular summer stratification, during which cold bottom waters are isolated ("cold pool"), and become nutrient-enriched. Upwelling events cause the cold pool waters to flow onshore. Our recent analysis of satellite imagery and wind stress data indicates that upwelling favorable winds are prevalent in the summer and trigger persistent upwelling. From our 33-year research efforts and the 45 year Delaware River Basin Commission monitoring program, we see occasional cold water and nutrient enrichment at the bay mouth that is due to the cold pool upwelling into the lower bay. We have begun a monitoring effort using the Cape May Lewes ferry that crosses the mouth of the Delaware Bay multiple times daily. Using the new ferry sampling system in 2010, we were able to capture the upwelling events and nutrient enrichment. In 2011, an automated monitoring system aboard the ferry will help us quantify how river discharge and coastal upwelling influence biological productivity in the lower Delaware Bay region.

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CRAB MEDIATED TIDAL CREEKS FORMATION IN SALT MARSHES

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. Crab burrowing and herbivory might affect creek erosion, but little is known about how this process varies among crab species. We conducted field and mesocosm experiments to examine the burrowing and herbivory rates of four common marsh crabs (Sesarma reticulatum, Eurytium limosum, Panopeus herbstii, Uca pugnax). Various densities of crabs were studied to determine how each crab population affects Spartina productivity and the amount of soil excavated. We used the mesocosm excavation rates and field density data to determine the potential yearly erosion rate of each crab species. The four crab species differed in their impacts. Sesarma excavated the most soil (~146g/week/crab) and reduced both below and above-ground Spartina biomass. The other three species did not significantly impact Spartina productivity. The level of biomass variation varied across the marsh but was highest at the creek heads. The crab community can turn-over the marsh surface multiple times per year. Creek heads with vegetation removed grew at a significantly faster rate (2.3 m/yr) than control creeks (1.5 m/yr). In sum, crabs may mediate creek growth in response to sea level rise by excavating sediments, by indirectly damaging plant roots and weakening their ability to bind marsh sediments, and by directly consuming marsh plants. Because different crab species differ in these effects, the net impact

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of the crab community on marsh responses to sea level rise is a function of the relative abundance of different crab species.

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**INFLUENCE OF SEA LEVEL RISE ON SALT INTRUSION AND MIXING IN MEKONG RIVER ESTUARY**

Viet Nam is one of the world’s top five most vulnerable countries to sea level rise and the most vulnerable to climate change impacts in South East Asia. Among the areas affected by climate change, the Mekong delta is the most affected areas, particularly affected by sea level rise. Also the Mekong River delta plays an important role in the Vietnamese economy and it has been severely impacted during this century by salinity intrusion, sea level rise. Salt intrusion and mixing in river are complicated under influence of tide, flow changes and sea level rise. The three dimensional hydrodynamic SUNTANS model (Fringer et al.2006) was applied to determine the effect of sea level rise on the estuarine mixing and salt intrusion in Mekong river delta. A series of scenarios were simulated with low (741 m/s3), normal (1112 m/s3) and high (1482 m/s3) freshwater inflows together with sea level rise of 0 m, 0.3m, 0.65 m and 1 m. In addition, effects of wind and tides were also considered. In this paper, we present the results of a hydrodynamic modelling study to test the hypothesis: 1) sea level rise would lead to increase salinity intrusion in to river and the salinity stratification decrease under the different inflow conditions and tides; 2) Increased freshwater inflows has the effect of increasing salinity stratification. In addition, the relationship between sea level rise, fresh water inflows with salinity distribution will be constructed. Acknowledgement: This work was supported by grants from International exposition Yeou Korea 2012.

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**LATE HOLOCENE CHANGES IN DIATOM COMMUNITIES IN SOUTH FLORIDA ESTUARIES CAUSED BY CLIMATE VARIABILITY AND ANTHROPOGENIC ALTERATIONS OF WATERSHED ON THE SOUTH FLORIDA MAINLAND**

Abrupt shifts in physical and ecological systems that can involve all trophic levels of marine food webs, have been the focus of many investigations around the world. These shifts were often linked to short- and long-term climate variability. The nearshore habitats of Florida Bay and Biscayne Bay have been greatly affected by intensive urban development in South Florida that have been superimposed on long-term climate-driven changes and sea level rise. Due to the planned environmental restoration in South Florida, it is imperative to determine the impact of these changes on the marine biota and to determine what the response of organisms to climate variability was in the past. In order to accomplish these goals, we evaluated compositional changes in diatom distribution with depth/time in 7 sediment cores collected from across Florida Bay and Biscayne Bay using a parametric method based on sequential t-test analyses of regime shifts (STARS), developed by Rodionov (2004). Our analyses revealed that the timing of major shifts in species composition of diatoms in the estuaries often overlapped with shifts in species composition of other marine microorganisms, major shift in climate conditions and anthropogenic activities. Largest changes in the 20th century occurred in the 1950's, 1960's and 1970's and corresponded to changes in ENSO model, occurrence of hurricanes and construction of water structures along the mainland, and they encompassed the entire estuarine region. Significant changes in the 1600s and 1800's correspond to periods of very low sun activity (Maunder and Dalton Minimums) during the Little Ice Age. We conclude that marine biota in South Florida estuaries respond to disturbances of environment caused by different natural and anthropogenic drivers, but it is difficult to distinguish which drivers play larger role in that process. Because different regions in the bays are influenced by different drivers, changes in biota are not always simultaneous.

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**FEEDING EFFICIENCY OF THE LARVAL Ctenophore Mnemiopsis leidyi A. AGASSIZ (Ctenophora, Lobata): THE TRANSITION FROM CYDIPPID TO LOBATE BODY**

The lobate ctenophore, *Mnemiopsis leidyi*, is an important planktonic predator in estuaries and bays along the US Atlantic coast. *Mnemiopsis leidyi* exhibits four distinct life-history stages during development: 1) tentaculate-stage cydippid larva, 2) transition-stage larva which possess both tentacles and small, developing oral lobes, 3) lobate larva whose tentacles have been resorbed yet are not reproductive, and 4) post-larval, reproductive lobate adults. Although adult, lobate *M. leidyi* are known carnivores capable of significantly reducing zooplankton populations and altering ecosystem dynamics, larval and juvenile *M. leidyi* are omnivorous and can be sustained on a diet of microplankton for short periods of time. Experiments were designed to investigate the feeding efficiency of *M. leidyi* on metazoan prey during their larval development and as they transition to lobate adults.

Results confirm that newly hatched larvae are damaged by metazoan prey and, thus, require microplankton prey and development; however, a small increase in size translated to a rapid increase in feeding efficiencies allowing larvae to effectively consume mesozooplankton thereby fueling rapid growth. During the transition stage, *M. leidyi*’s feeding success declined as the tentacles were resorbed and the lobes still represent a small surface area for capturing mesozooplankton. The apparent success of the *M. leidyi* cydippid larval stage and, perhaps even co-occurring adult cydipids such as Pleurobrachia pileus provides interesting ground to investigate the evolutionary mechanisms driving the appearance of the lobate adult form of *M. leidyi*.

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**TEXAS AUTOMATED BUOY SYSTEM (TABS) SUSTAINABLE OCEAN OBSERVATIONS TO PROTECT THE COASTAL ENVIRONMENT**

The Deepwater Horizon oil spill off the coast of Louisiana in 2010 woke the country once again to the inherent risks involved in offshore drilling. The overall cost of this spill will not only be measured in dollars, but also in the tragic loss of life, environmental damage to coastal wetlands and damage to the psyche of many of the local residents. The oil industry tries to mitigate the chance for accidents by requiring proper personnel training, daily regular safety and toolbox meetings and regular equipment maintenance. Regardless of the quality of training, equipment and procedures, accidents still occasionally occur. Some of these accidents will inevitably result in oil being discharged into the environment. Being prepared to act on an oil spill when it occurs is critical to being able to mitigate potential impacts. There is a great need for timely knowledge and understanding of the environment in which a spill occurs. This is why in October, 1994 the Texas General Land Office (TGLO) contracted the Geochemical and Environmental Research Group (GERG) of Texas A&M University to develop the Texas Automated Buoy System (TABS). It is the only state funded ocean observing system in the country whose principle mandate is to provide near real time oceanographic and meteorological data for the purpose of oil spill trajectory modeling. For the past 16 years, TABS has provided response managers with the data necessary to accurately predict oil spill trajectories so the environmental and economic impacts are minimized. Over this period, data from TABS has been used for decision making purposes in over forty spill events off the coast of Texas. The first few minutes after a spill occurs are critical to determine how to treat the spill, how and where to intercept it and to determine what resources are required. TABS provides that vital information to allow response managers to act and mitigate the potential impact from an oil spill.

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**SEABED AND SHORELINE DYNAMICS OF THE ALBEMARLE-PAMLICO ESTUARINE SYSTEM**

Estuaries are critical habitats as well as places where people live, recreate, and make their livelihood. Additionally, they are sites where land and sea interact, and sediments, and associated pollutants and carbon, are deposited, remobilized and accumulated. Many processes, such as river discharge, waves, tides, and sea-level rise, are operating in estuaries to cause sediment dynamics, impacting humans and organisms as a result. Recent research we have been engaged in across the Albemarle-Pamlico Estuarine System (APES) has investigated the seabed and shoreline dynamics of this important estuary. The APES is the second largest estuary in the continental United States, consisting of the Albemarle and Pamlico sounds and the Pamlico River and Neuse River sub-estuaries. Although expansive in size, the system is shallow with minimal tidal range. Water and sediment discharge into the APES is modest, and the existence of few inlets along the Outer Banks limits mixing with the Atlantic Ocean. Human impact on the drainage basin and estuarine system is moderate and increasing over time. Over the last five years, a considerable volume of sedimentary process data has been collected over various timescales and locations in the APES. More specifically, work has included: deployments of instrumented tripods to examine seabed dynamics; collection and analysis of shallow cores and GIS investigation of aerial photographs and other data. This wealth of data highlights several insights: 1) shoreline change although variable is generally eroding at the average rate of ~0.25 m/yr; 2) seabed erosion and deposition is inconsistent, but net accumulation of 2-4 mm/yr is widespread; and 3) storm-wave activity and river sediment discharge are important to this shallow but large estuarine system.

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**WAVE DRIVEN EXCHANGE BETWEEN CORAL REEF LAGOONS AND THE COASTAL OCEAN**

Residence time is an important parameter controlling many biological processes in coral reefs. Measurements of circulation were carried out on a reef and lagoon system in Moora,
French Polynesia using GPS drifters and moored acoustic Doppler current profilers. Drifters released in water exiting through passes in the reef were re-entrained to the reef by the wave driven and alongshore flows, thus greatly increasing retention and residence time. The field measurements indicate that the amount of retention and recirculation depends on the wave forcing, the alongshore current and buoyancy differences. A numerical simulation of the flow with a simplified geometry was created to explore these relationships. The numerical simulations were consistent with the field observations, and also show reef geometry has a substantial impact on the amount of water retained by the reef.

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**OYSTER DECLINES FROM BOATING ACTIVITIES AND GAINS FROM RESTORATION IN MOSQUITO LAGOON, FLORIDA**

Globally, bivalve reefs have declined by 85% over the past century. On the east coast of central Florida, in the shallow (mean: 1.5 m depth) waters of Mosquito Lagoon (northern Indian River Lagoon) one of the primary threats to reefs of the intertidal oyster *Crassostrea virginica* is wakes from recreational boats. Wakes dislodge live oyster clusters and tumble them into piles that extend above mean high water. Because the area is also microtidal, the clusters do not roll back down these piles and the oysters subsequently perish, with only bleached piles of disarticulated shells remaining. If only shells remain, they are referred to as dead reefs. If only the outer edge of a reef is dead, it is called a dead margin. No-wake zones are unlikely to be developed for this popular fishing area, so restoration protocols were developed that could withstand the intense boating activities. Mesh squares with attached oyster shells were created by hundreds of individuals and community groups to be deployed by volunteers. The mesh provided a stable substrate that prevents future dislodgment. To date, 42 reefs have been stabilized and restored using this methodology with the assistance of over 20,000 central Florida volunteers. With an average of 188 live oysters per square meter on restored footprints in 2010, we have created habitat for nearly one million oysters so far. Stabilized reefs have not developed new dead margins. Stabilizing the sediments has led also to local seagrass recruitment. Our current goal is to restore all dead margins/reefs within Canaveral National Seashore in Mosquito Lagoon while creating outreach products that will produce more responsible boaters.

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**IMPROVING THE INDIAN RIVER LAGOON THROUGH COMMUNITY-BASED OYSTER REEF RESTORATION**

Oysters and the reefs they form are essential in estuaries for water filtration, protection from shoreline erosion, structural refugia for many invertebrate and fish species, and as a source of protein. Unfortunately, 85 percent of these reefs have been lost globally, making oyster reefs one of the most severely impacted marine habitats on this planet. In the Indian River Lagoon on the east coast of Florida, boat and wind wakes have damaged 19 percent of reefs within the boundaries of Canaveral National Seashore. Community-based reef restoration began in 2007 to reverse this trend. This program has been wildly successful with over 20,800 volunteers participating to date and contributing over 34,000 volunteer hours to this project. Between 2007 and 2010, the program has added over 2 million oysters to the Indian River Lagoon. We are excited to continue with this project for many years to come, both for environmental stewardship and educational outreach.

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**SOURCE-SINK DYNAMICS IN MARINE SYSTEMS: SEMANTICS AND MECHANISMS**

Many marine and freshwater species inhabit a patchy world, where populations are connected to one another through the migration and dispersal of individuals at particular life history stages. A large amount of research has focused on the connectivity of metapopulations, both theoretically and empirically, in an attempt to address applied management issues such as the design of spatially explicit reserves. Much of this work has focused on quantifying the strength and direction of dispersal pathways. This research has included the use of radiotelemetry, chemical tagging, genetic assignment and coupled biophysical modeling to identify origins and trajectories of individuals. Source habitats may include those that serve as nurseries, refuges, or spawning grounds. In parallel, management strategies have focused on preserving spatial arrangement of habitats that will maximize population resilience. In order to identify those habitats that are of maximal importance, the influence of habitat quality on population dynamics of mobile species must be understood. Approaches to studying source-sink dynamics can occur at the individual, population, community and ecosystem levels. At each level different metrics are utilized, however these metrics have to be properly matched to the mechanisms of interest. We also highlight the importance of incorporating life histories and temporal variance when defining source-sink dynamics. While presentations will be diverse in terms of systems or approaches, at the panel discussion we will address the central theme: how does the quality of the source affect population dynamics of mobile species?

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**STABLE ISOTOPE RATIOS IN OYSTER SHELL CARBONATE AS PROXIES OF DROUGHTS AND FLOODS IN SUBTROPICAL ESTUARIES**

The eastern oyster, *Crassostrea virginica*, contains geochemical records in shell hinge growth increments, and stable isotope profiles of δ18O and δ13C, sampled from the shell, can be used as proxies for local temperature and salinity fluctuations. The primary aim of this project was to use shell isotope ratios to identify the 2009 post-drought flood event, which altered estuarine salinities substantially in some regions of the southern Texas coast. Oyster isotope time series were compared from two locations in the Aransas-Copano Bay system that experienced distinctly different environmental fluctuations. Isotope time series were matched to temperatures and salinities recorded by nearby gauged stations to determine the relative influence of each variable. Shell values of δ18O responded primarily to salinity while δ13C responded to both temperature and salinity. Clear flood signals were evident in both isotope ratios for shells from one location, reflecting the significant drop in local salinities during the flood. In contrast, profiles from shells in the other location lacked distinct flood signals, indicative of relatively stable local salinities. Stable isotope analysis of increments in biogenic structures is a useful method to reconstruct timing and frequency of flood events in estuarine environments. The combined use of both carbon and oxygen isotope proxies strengthens the ability to tease out temperature and salinity variations in these dynamic and spatially heterogeneous habitats.

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**EFFECTS OF SEDIMENT AND NUTRIENT ON WATER CLARITY IN CHESAPEAKE BAY**

The Chesapeake Bay TMDL on SAV (submersed aquatic vegetation)/water clarity aims to improve water clarity to achieve the SAV acreage goal through controlling nutrient and sediment load to the Bay from its watershed. Based on monitoring data, the correlations between light attenuation coefficient, Kd, with in-situ total suspended solid (TSS) and chlorophyll (Chl) concentrations in the 102 segments indicates that the Kd is closely related to in-situ TSS and Chl concentrations. However, the relative strengths of the correlation are different among segments. They are distinct between more saline and fresher water segments. In general, in lower salinity segments Kd is more correlated to TSS, which is mainly related by its influences by the fall-line sediment source. The distinctions among tributaries are less, which is mainly related to tributary features that have different sediment versus nutrient inputs. The correlation between Kd with sediment and nutrient loads from the watershed is more complex, and Kd is correlated to Chl concentrations due to lag time of response of TSS and Chl (in water) to the loads and due to diverse loading sources to a segment. Water clarity in tidal fresh or oligohaline segments is influenced significantly by both sediment and nutrient loads, dominantly by sediment in most cases. Nutrient effect on water clarity becomes more important in mesohaline and polyhaline segments. We applied water quality model and used a set of scenarios with differential sediment and nutrient loads to study relative contributions of sediment and nutrients loads to light attenuation in the Bay segments. The model yields similar results to the above analysis using observed data. Based on the model results we developed a method to estimate sediment and nutrient load reduction to achieve a target Kd in segments, providing guidance in sediment and nutrient TMDL.

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**DIVERSITY AND ABUNDANCE OF GENES REPRESENTING MICROBES RESPONSIBLE FOR NITROGEN REMOVAL IN OXYGEN DEFICIENT ENVIRONMENTS**

Nitrogen loading in coastal environments has increased dramatically over the past few decades. In some coastal regions, apart from the anthropogenic sources, naturally occurring processes, such as upwelling, also contribute high N loading. Increased N input leads to high primary productivity (PP) that results in suboxia and hypoxia in water column, due to increased respiration that follows the organic loading from high PP and land drainage. Such systems, found off the coast of SW India and Eastern Tropical South Pacific (ETSP) are regions of intense N cycling through anaerobic microbial processes, denitrification and
anammox, transforming fixed N to gaseous end products. To gain insights into the composition, diversity and abundance of the organisms responsible for N removal in oceanic Oxygen Deficient Zones (ODZ), we analyzed DNA samples and present data from some of these hotspots that include the seasonally occurring Coastal Arabian Sea (AS), open ocean AS and ETSP. Diversity was evaluated using nirS and nirK genes for denitrifiers and the 16S rRNA gene for anammox bacteria. The nirS genes from the AS are not closely related to other published sequences, and the closest identity is with sequences from other water column denitrifying environments. Phylogenetic analysis of the nirS shows that the overall denitrifier diversity is high in the AS, while that of the anammox 16S rRNA is considerably lower and was represented by a single type. Based on Q-PCR assays of nirS, nirK (denitrifiers) and anammox 16S rRNA gene abundance, we found that denitrifiers greatly exceed anammox bacteria in both the AS and the ETSP upwelling region. Even at stations where nirS rates are high, anammox abundance and diversity was very low and ranged from 2 to 12% of the total nirS abundance. These genes abundances imply that denitrifying and anammox bacteria represent a variable proportion of the total microbial community, and both were undetectable in surface waters.

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COMPARISON OF NATURAL AND RESTORED INTERTIDAL OYSTER REEFS IN GEORGIA

The restoration of oyster reefs has long been associated with producing harvestable oysters; however, oyster reefs also help improve water quality, reduce shoreline erosion, reduce predation, and provide habitats for transient and residential fauna. The complex vertical structure of oyster reefs provides settlement sites for oyster spat and habitat and refuge for small estuarine animals. The purpose of this study was to determine whether the vertical structure of restored intertidal oyster reefs is similar to that of natural intertidal oyster reefs in Georgia. Reef vertical structure was measured in 2 ways. Rugosity was measured by placing a 200 cm metal-linked chain along the vertical and horizontal surfaces of the reef and measuring the horizontal distance covered. The shoreline slope was measured at 1 m intervals using a laser level placed at the top of the reef. Percent cover of live and dead oysters, barnacles, bare mud, and marsh grasses was also recorded in 1 m² quadrats. Data were collected along 3 transects at each of several natural reef sites and restored reefs that were constructed with a variety of materials. Preliminary results indicate that the rugosity of reefs restored using shell bags (1 year after construction) varied from 174 ± 5 cm to 188 ± 1 cm, whereas the rugosity of natural reefs varied from 126 ± 6 cm to 165 ± 5 cm. Percent cover of live oysters on the restored reef varied from 13 ± 10% to 22 ± 19%, and on natural reefs from 47 ± 11% to 59 ± 12%. One year following construction, reefs restored using shell bags had less vertical structure and a lower percent cover of live oysters than reefs restored using other methods as compared to nearby natural reefs, suggesting that more time is needed for these reefs to reach a natural functioning state.

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A NEW METHOD FOR CALCULATING FORM DRAG AND ENERGY CONVERSION DUE TO TIDAL FLOW PAST A HEADLAND

Three Tree Point is a headland that juts into the Main Basin of Puget Sound, WA. In the current study, field observations are combined with a numerical model to investigate the role of tidal flow past a headland. The potential energy due to choking of the flow on the seaward slope of the hollow. The potential energy anomaly, a measure of the amount of energy required to fully mix the water column, showed

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SALT MARSH PLANTS AND CHRONIC EUTROPHICATION: VEGETATION, GROWTH RESPONSES AND N REMOVAL IN A NEW ENGLAND ESTUARY

Ten to twelve salt marsh creeks that have been restored to remove tidal water enriched to 10-15X ambient NO₃⁻, Ca. 50 - 70 μM, over eight growing seasons. Vegetation patterns on the high marsh of treated and reference creeks were similar in 2003 and have not changed significantly over the course of the experiment. Relatively small inter-annual changes in species cover and frequency tracked closely between treated and reference creeks, suggesting system-wide forcing factors. Low marsh, creek-mouth, Spartina alterniflora in treated creeks had consistently greater leaf N than in reference creeks. Individual shoots of low marsh S. alterniflora also showed consistently greater above ground growth. Greater stem densities in reference creeks, however, resulted in no differences for above ground production estimates. Below ground biomass of fertilized creek bank S. alterniflora was greater in reference creeks. On the high marsh there were no consistent differences in leaf N content or above ground plant growth in Spartina patens, Stunted S. alterniflora, or Distichlis spicata. The capacity of above ground plant growth to remove water column N (g N m⁻² yr⁻¹) was not significantly different between treatments for any species. On average, creek-mouth S. alterniflora sequestered 17-18 g N m⁻² yr⁻¹, S. patens ca. 5 g N m⁻² yr⁻¹, and high-mash S. alterniflora 6.7 g N m⁻² yr⁻¹. This lack of strong differences between treatments for plant N mass, plant production, and vegetation patterns suggests that the capacity of plants to sequester excess water-column N in their tissues is limited, at least in this ecosystem. Overall, our relatively low level of fertilization may have exceeded the N processing capacity of the salt marsh plant community.

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INTEGRATING SOCIAL SCIENCE INTO ECOSYSTEM BASED MANAGEMENT: A CASE STUDY OF LAND USE DECISION MAKING IN COASTAL NEW HAMPSHIRE

The New Hampshire seacoast is a mere 18 miles in length, but includes over 40 coastal watershed communities experiencing tremendous population growth and development pressure resulting in sprawl, increased imperious surface cover and larger lot rural development. This pressure challenges land use decision-making and threatens the ecological health and functioning of Great Bay, an estuary designated as both a NOAA National Estuarine Research Reserve and an EPA National Estuary Program site. These challenges have resulted in calls for strategies addressing growth, development and land use planning. The ecological condition of Great Bay and the need for watershed based approaches, led to the question, is there a potential for re-framing land use decision making at the watershed scale? The answer to this question is discussed through a case study of the social landscape of land use decision-making. The Lamprey River watershed and its 14 communities were chosen as the case study. A mixed social science methodology was employed, including semi-structured interviews and GIS maps of all potential development. Grounded theory was used as the analytical strategy resulting in a theoretical framework and an opportunity for participatory action research. Data was collected from both primary and secondary sources, where the latter consisted of experts and professionals affected by or influencing land use decision-making such as developers, realtors and planners. Primary data sources included representatives from town planning boards, conservation commissions, zoning boards, open space committees and heritage or historic district commissions. This paper presents the case study, methods, key findings, results and outcomes of this applied social science approach.

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TIDAL ASYMMETRIES IN VELOCITIES AND STRATIFICATION OVER A HOLLOW OF A TROPICAL INLET

Observations of current velocity, sea surface elevation and vertical profiles of density were obtained in a tropical inlet to determine the effect of a bathymetric depression (hollow) on the tidal flows. Surveys measuring velocity profiles were conducted over a diurnal tidal cycle with mixed spring tides during dry and wet seasons. Depth-averaged tidal velocities during ebb and flood tides behaved according to Bernoulli dynamics, as expected. The dynamic balance of depth-averaged quantities in the along-channel direction was governed by along-channel advection and pressure gradients with baroclinic pressure gradients only being important during the wet season. The vertical structure of the along-channel flow during flood tides exhibited a mid-depth maximum with lateral shear enhanced during the dry season as a result of decreased vertical stratification. During ebb tides, along-channel velocities in the vicinity of the hollow were vertically sheared with a weak return flow at depth due to choking of the flow on the seaward slope of the hollow. The potential energy anomaly, a measure of the amount of energy required to fully mix the water column, showed
two peaks in stratification associated with ebb tide with a third peak occurring at the beginning of flood. The reasons for this peculiar behavior is explained.

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ECOLOGICAL AND EVOLUTIONARY GENETICS OF SEAGRASS POPULATIONS

The advent of readily accessible, cost effective high resolution genetic markers has enabled the identification of clonal genetic individuals, the determination of parentage, population structure and gene flow. In addition, new initiatives at the genomic scale will provide insight into selection driven adaptive landscapes. Two fields of study benefit significantly from the availability of these markers: population ecology and evolutionary biology. Published data on seagrass genetics has provided evidence that ecological processes for seagrasses are sometimes dramatically different to our expectations. For example, the determination of population structure in turtlegrass (Thalassia testudinum) has revealed that in the majority of randomly sampled populations clonality is not the dominant descriptor of population structure). Similarly, all species studied to date using microsatellite markers including Zostera marina, Z. noltii, Posidonia oceanica, P. australis and Halophila ovalis typically exhibit diverse mixed population structure. However, occasionally, populations are comprised of few genetic individuals or very large clones. The causes of these highly clonal populations can typically be related to ecological processes such as population isolation, disturbance regime or habitat change. Genetic data also provide significant insights into evolutionary processes. Broadscale population genetic surveys indicate biogeographic relationships and aid in the reconstruction of evolutionary histories. In addition, analysis of closely related taxa can provide insight into phylogeographic relationships and when coupled with systematic analysis can resolve taxonomic issues. A closer link between understanding the evolutionary relationships among currently recognized seagrass taxa and ecologically driven phenological diversity will only improve the taxonomic resolution in this enigmatic group of marine plants.

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NUTRIENT EFFECTS ON SPARTINA ALTERNIFLORA AND AVICENNIA GERMINANS: IMPLICATIONS FOR COMPETITION IN A MARSH-MANGROVE ECOSYSTEM

Climate change impacts such as increasing temperatures are likely to strongly influence coastal ecosystems. Avicennia germinans (black mangroves) have a complex, tall morphology and can outcompete salt marsh grasses unless freezing events limit mangrove expansion. Warmer temperatures will facilitate A. germinans range expansion, making Spartina alterniflora (smooth cord grass) dominated salt marshes vulnerable to competitive displacement. Climate models also predict an increase in runoff, potentially increasing anthropogenic nutrient input into these systems. A. germinans and S. alterniflora are both sensitive to enrichment, therefore increased nutrient input may alter the competitive dynamics between these two species. Twenty-two 4-m² plots containing both A. germinans and S. alterniflora in Port Aransas, Texas were fertilized to explore how nutrients impact these two co-existing species. In January 2011, after 7 months of enrichment, A. germinans leaf nitrogen content was 42% higher in enriched plots compared to ambient nutrient treatments; S. alterniflora leaf nitrogen content showed no treatment differences. S. alterniflora did show a nutrient response in April 2011, the start of the growing season, with increased leaf width and stem height (30% increase) in enriched plots. A. germinans trunk height was not affected by nutrient treatment. Morphological nutrient effects appeared to be stronger in S. alterniflora during the start of the growing season, potentially giving marsh grasses a competitive edge. Climate change may facilitate black mangrove migration into northern Gulf of Mexico salt marshes, and the dynamics of this state change will likely be altered by nutrient input.

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EVALUATING THE RELATIONSHIP BETWEEN HABITAT ALTERATION AND RESOURCES SPECIES ABUNDANCE IN NORTH CAROLINA ESTUARIES: DO FISH RESPOND TO ANTHROPOGENIC ACTIVITIES?

As habitat based management initiatives become more widespread in fisheries management and conservation it is important to be able to differentiate between areas impacted by human activities and those that are relatively untouched. Cumulative impact approaches have been used to measure anthropogenic effects regionally and globally; however, there have been few attempts to test if these cumulative impacts result in lowered fish abundance or production. The North Carolina Division of Marine Fisheries has developed a method for combining the effects of 23 different human activities into one metric of anthropogenic alteration in a specific area. This measure of alteration is being used in site selection software as a metric to be minimized when selecting habitats for potential protection. The assumption of this approach is the alteration metric is negatively related to measured fish abundance. Long term fishery independent monitoring datasets in Albemarle and Pamlico Sound, North Carolina were used to test the relationship between alteration levels and abundance of resource species using generalized additive models. For some species, there was a negative relationship between fish abundance and alteration scores indicating that the cumulative impact score reflects attributes of the habitat that influence fish abundance. These results support the use of cumulative impact models for assessing habitat condition and will be incorporated into state level habitat protection planning initiatives.

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SYNOPTIC SURVEYS OF NEAR-SURFACE HYDROGRAPHY IN A GULF OF MEXICO ESTUARY

Mobile Bay (Alabama) is a broad, shallow micro-tidal estuary located on the North Central Gulf Coast. Although the bay is shallow (~1 m), it can become highly stratified due to large freshwater inputs from the Alabama and Tombigbee Rivers. Dynamics of the bay are further complicated by a deep (~15 m) ship channel that runs from Main Pass, the Bay’s connection to the Gulf of Mexico, to the Mobile State Docks. Although the Bay is significant in terms of both its dynamics and its economic viability for seafood, very little is known about the spatial distribution of salt, heat, and other parameters within the estuary. As part of a BP Gulf Research Initiative Phase I research project in the State of Alabama, synoptic surveys of the Bay’s near-surface characteristics are being made with some unique instrumentation deployed on a personal watercraft. The response of the Bay’s hydrography to tidal, wind, and freshwater forcing will be discerned as a component of this year-long research project focused on the distribution and dispersion of pollutants under the action of ocean forcing.

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COASTLINE CHANGE DETECTION UTILIZING GROUND-BASED LASER SCANNING

Coastal erosion from storm surges and rising sea-levels are a problem throughout Maritime Canada. A coastal section in Cape John, Nova Scotia with bedrock headlands that form an embayment which has relief and material that range from steep bedrock cliffs to a glacial till bank and a dune and salt marsh environment. The area has been studied utilizing traditional airphoto change detection methods and rates calculated. However, because the airphotos are acquired on a decadal scale, it is difficult to quantify the effects of a single storm event or storm season. Airborne lidar has been acquired over the site yearly since 2006; however the rates of erosion have been at the precision limit of these surveys. The focus of this study has been to examine the change of the till bank over a storm season. A ground-based lidar unit was used to survey the till bank in June, July, Oct. and Dec. 2010 and in Jan. 2011 to monitor change. The point clouds and derived surface models were compared to GPS transects. The points and surface models were used to assess the gradual erosion from June to Dec. and the catastrophic event recorded on Dec. 21 and 20th. A weather station and tide gauge were also deployed to capture the environmental conditions during these events. The Dec. 21 Nor’easter storm caused extensive coastal flooding and erosion for many coastal communities with shorelines exposed to the north and east. The tide gauge indicates a maximum water level of 2.2 m and the debris wrack line GPS elevation is 2.4 m. The vertical limit of erosion along the bank is between 4-5 m based on the longitudinal and transverse profiles. Along a 150 m section of the bank, 771 cubic meters of material was removed between Dec 16 and Jan 4. The current bank slope is very steep with the ground frozen but is expected to slump when the frost leaves the ground. Additional ILRIS scans are planned to document this part of the processes until the bank slope and beach reach equilibrium again.

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AN INVASION POTENTIAL SCORECARD: INCORPORATING THE HUMAN AND ECOCLOGICAL DIMENSIONS OF AQUARIUM SPECIES RELEASE

The aquarium trade serves as a major introduction pathway for non-native species in Texas. Aquarium owners purchase freshwater and marine species of finfish, shellfish, and aquatic plants from Asia, South America and Africa with the intention of maintaining them in
aquatic or ponds. However, non-native aquatic species are found in Texas waters, making their way through escape or intentional release; there has been extensive research on non-native species introduction, establishment, spread, and impact on human and natural systems. However, little management-oriented work has been conducted on human actions and values contributing to invasive species introduction. This project seeks to better understand how knowledge and values influence the decision making process, what drives the decision to release ornamental fish, and to contribute to better risk assessments. The results provide managers with information to better mitigate long term effects of non-native, invasive species and design more comprehensive public outreach strategies. We hypothesize that 1) knowledge and values are important factors in the decision to release and new knowledge may not necessarily trump long held values; 2) outreach campaigns incorporating only information on harm of invasive species to the environment are less effective than campaigns that acknowledge the potential tension between knowledge and values; and 3) risk assessments do not accurately assess risk because they do not consider all market outlets and intentionality. We employ in-person and web-based surveys, interviews, statistical analysis, and assessment of coastal waters in relation to environmental optimas for 7 species of fish. Results and stakeholder input are used to develop an Invasive Potential Scorecard that rates species’ invasion potential based on availability of species for purchase, the likelihood of species being released, and the species’ ability to become established in the ecosystem in which it is released.

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ENVIRONMENTAL DETERMINANTS OF EMERGENT MACROPHYTE VEGETATION IN PACIFIC NORTHWEST ESTUARINE TIDAL WETLANDS

We investigated whether within wetland environmental conditions or surrounding land use measured at multiple scales were more influential in structuring regional vegetation patterns in estuarine tidal wetlands in the Pacific Northwest, USA. Vegetation communities were characterized by high species richness, lack of monotypic zonation, paucity of invasive species, and different dominant species from wetlands along the east coast of the U.S. The number of species per site ranged between 4 and 20 (mean = 10.2 ± 3.1). Sites supported a high richness (mean richness of native species (8.7 ± 2.8) and abundance of native macrophytes (mean relative abundance 85% ± 19%). Vegetation assemblages were dominated by a mix of grasses, sedges, and herbs, with Salicornia depressa and Distichlis spicata being common at sites in the oceanic zone of the estuary and Carex youngii and Agrostis stolonifera being common at the mixing zone sites throughout the study area. The vegetation community was most strongly correlated to within wetland salinity and land use within close proximity to the study site. Total species richness and richness of native species were negatively correlated to the amount of wetland in the buffer at all scales, while abundance of invasive species was significantly correlated to within wetland factors, including salinity and dissolved phosphorus concentrations. Landscape factors related to anthropogenic disturbances were only important at the 100m buffer scale, with anthropogenic disturbances further from the wetland not being influential in shaping the vegetation assemblage. Our research suggests that the traditional paradigms of tidal wetland vegetation structure and environmental determinants developed in east coast U.S. tidal wetlands might not hold true for Pacific Northwest wetlands due to their unique chemical and physical factors, necessitating further detailed study of these systems.

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REVERSING TWO CENTURIES OF WETLAND DEGRADATION: CAN SCIENCE BETTER INFORM POLICY & PRACTICE?

Throughout history, wetlands and other habitats at the land–water interface have been largely “reclaimed” for human use, essentially extirpating other goods and services that these ecosystems provide. It is only in the past 60 years that the societal value of riparian ecotones has been recognized, but although promising new efforts are leading to substantial wetland restoration science and practice as practiced today is addressed. Methods for better integration of science and practice to inform policy and the quantification of restored functions are presented in the context of several case histories.

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A CASE STUDY IN SEA LEVEL RISE: CAN PRIVATE PROPERTY OWNERS PROTECT THEIR PROPERTY AGAINST RISING TIDE LEVELS WITHOUT HARD ENGINEERING SOLUTIONS?

A coastal area with rapidly increasing water-levels may provide insights and/or lessons for A coastal area with rapidly increasing water-levels may provide insights and/or lessons for coastal managers and coastal engineers concerning the decision to release ornamental fish, and to contribute to better risk assessments. The results provide managers with information to better mitigate long term effects of non-native, invasive species and design more comprehensive public outreach strategies. We hypothesize that 1) knowledge and values are important factors in the decision to release and new knowledge may not necessarily trump long held values; 2) outreach campaigns incorporating only information on harm of invasive species to the environment are less effective than campaigns that acknowledge the potential tension between knowledge and values; and 3) risk assessments do not accurately assess risk because they do not consider all market outlets and intentionality. We employ in-person and web-based surveys, interviews, statistical analysis, and assessment of coastal waters in relation to environmental optimas for 7 species of fish. Results and stakeholder input are used to develop an Invasive Potential Scorecard that rates species’ invasion potential based on availability of species for purchase, the likelihood of species being released, and the species’ ability to become established in the ecosystem in which it is released.

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Ecosystem Services generated by Oyster Reefs along the Texas Gulf Coast: Indicators of the Value of Freshwater Inflow

Freshwater inflow is vital to the health of estuaries, yet its value compared to the competing use of water diversion for upland users remains vague and poorly investigated. Inflows dilute sea water in coastal bays to create low-salinity nursery habitat and refuges from marine predators. Along the Texas coast, inflows decline from north to south, and oyster distribution generally follows the same trend. This distribution is strong evidence that oyster reefs are critical to fisheries and tourism. The method was used to estimate fishing recreation dollar values of reefs from a function derived by substituting cost of equivalent nitrogen removal by a water treatment plant. Value transfer methods were used to estimate fishing recreation dollar values of reefs from a function derived in a 2004 Louisiana Department of Wildlife and Fisheries study. Finally, running ten-year average dockside commercial sales were used to estimate harvest values of oysters among the estuaries of differing flow regimes.

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Ichthyoplankton Community Dynamics in a Northeast Pacific Estuary: Willapa Bay, Washington, USA

Field examination of ichthyoplankton in conjunction with potential prey abundances and other environmental variables (e.g., salinity, water temperature, dissolved oxygen, etc.) provides an opportunity to explore the trophic dynamics of larval fish during the so-called “critical period” when recruitment success is thought to be established. Our sampling regimen consisted of bi-weekly or monthly plankton net tows (500 um mesh, 1.0 m diameter, and 73um mesh, 0.5 m diameter) and CTD casts over the course of a full annual cycle at three locations within Willapa Bay, WA, a Northeast Pacific estuary. Among the 20 larval fish species collected, Ictalurus punctatus was found with the greatest frequency, followed by Fundulus heteroclitus, Coregonus clupeaformis, and Fundulus majalis. The greatest diversity of ichthyoplankton species was found during late winter and spring, while the summer and fall were characterized by a single species, C. is. Additionally, ichthyoplankton composition varied geographically, with the more open water stations differing from the more sheltered station. Among juvenile fish, anomalopus collar and brook chub were dominant in July, and the other major prey species were sapsucker shiner, cisco, and brook chub. The results have been used to develop an Invasive Potential Scorecard that rates species’ invasion potential based on availability of species for purchase, the likelihood of species being released, and the species’ ability to become established in the ecosystem in which it is released.
These results shed light on the importance of food quantity and quality and other environmental variables as major drivers of estuarine ichthyoplankton dynamics.

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ESTABLISHING ENVIRONMENTAL FAVORABILITY FUNCTIONS FOR A MULTIVARIATE FISH ASSEMBLAGE IN THE LOWER ALAFIA RIVER, FLORIDA

The process for selection of inflow management criteria for southwest Florida tidal rivers often includes an evaluation of the influence of inflow variation on fish abundance. Assessment criteria for these evaluations tend to rely on “best fit” regression relationships between single species abundances and flows. However, the relationship between inflows and single species abundance patterns may be confounded by other environmental factors related to habitat preferences. In this study funded by the Southwest Florida Water Management District, we employed logistic regression to evaluate the probability of occurrence of many important individual fish taxa in the Alafia River, a tidal tributary to Tampa Bay, across a suite of habitat and environmental conditions. We then applied a method described by Real et al., (2006) to convert logistic based probability of occurrence information into environmental favorability functions by standardizing logistic probabilities to the empirical proportion of occurrences. By scaling the logistic function, the environmental favorability of commonly and rarely occurring species can be effectively combined (Estrada et al., 2008). The utility of this method in assessing the interaction of inflow variations with seasonality and habitat availability for a suite of fish taxa including estuarine recruiting and estuarine resident species is discussed.

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IMPROVING THE HEALTH, RESILIENCE AND PRODUCTIVITY OF THE GREAT BARRIER REEF AND ALLIED ESTUARINE AND COASTAL WETLAND ENVIRONS: A FUNCTION OF INNOVATIVE FARMING SYSTEMS

Australia’s iconic Great Barrier Reef is a World Heritage Area and is internationally recognised for its unique values. If the multiple pressures impacting upon the health of the reef and associated estuarine and coastal wetland environs, diffuse pollutant loads emanating from adjacent agricultural land uses are consistently recognised as one of the highest priorities for remedial action. The spatially dominant rangeland grazing sector along with sugarcane and horticulture (due in large to their intensity of inputs and proximity to the coast), have come under the most scrutiny. Over the last five years, Governments, Ag- Industry, Science Service Providers and the Community have invested considerable resources towards technologies and initiatives aimed at reducing the loads of nutrients, sediments and chemicals entering waterways and discharging to the reef. Despite this effort, there is now scientific consensus that there has not been sufficient improvement and that the wide spread adoption of new industry norms capable of balancing the economic realities of agricultural production with the long term health of the reef, are yet to be achieved. Under the auspices of the Reef Water Quality Protection Plan (2009), the Queensland Government through an integrated voluntary/self management and legislative framework, is working collaboratively with stakeholders in the trialling, implementation and validation of innovative, management options and farming systems approaches capable of delivering improved business and environmental performance. In addition to showcasing the operational environmental and farming systems approaches being progressed, the presentation will also overview allied policy and extension frameworks, catchment monitoring/modelling initiatives and Reef Plan reporting.

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SEA-LEVEL RISE AND SALT-WATER INTRUSION IN TIDAL FRESHWATER MARSHELSES AND SALT-MARSHES OF THE DELAWARE RIVER ESTUARY

Accelerating sea-level rise is putting tidal marshes at increasing risk of permanent submergence. Tidal freshwater marshes (TFMs) face the additional challenge of salt-water intrusion as sea-levels rise and freshwater inputs from watersheds decline. The overall response of marshes to these changing environmental drivers will be a complex interaction between plant production, microbial organic matter decomposition, and sediment deposition, which together determine rates of marsh vertical accretion. This talk will focus on understanding how sea-level rise and salt-water intrusion influence plant and microbial processes in TFMs and salt-marshes. In a laboratory experiment, soil cores collected from a TFM in the Delaware River Estuary were subjected to simulated salt-water intrusion. In a subsequent field manipulation, sea-level rise and salt-water intrusion were simulated by placing marsh mesocosms at various elevations at four sites along the salinity gradient in the Delaware River Estuary. Soil biogeochemistry, carbon dioxide and methane emissions, and rates of microbial sulfate reduction and methanogenesis were measured in both experiments, as well as plant biomass and species composition in the field manipulation. These studies indicate that salt-water intrusion stimulated microbial organic matter mineralization via sulfate reduction and, surprisingly (but transiently), methanogenesis. Sea-level and salt-water intrusion also strongly regulate plant biomass in TFMs and salt-marshes. Shifting plant species composition, together with changing rates of soil microbial organic matter decomposition, will ultimately determine if TFMs simply transform into salt-marshes or are permanently submerged following salt-water intrusion. Changes in plant production and soil C cycling have major implications for the accumulation of organic matter within marsh soils, emissions of greenhouse gases, and the ability of tidal marshes to keep pace with rising sea-levels.

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SEVERE DROUGHTS REDUCE ESTUARINE PRIMARY PRODUCTIVITY WITH CASCADE EFFECTS ON HIGHER TROPHIC LEVELS

We analyzed the effects of two severe droughts on water quality and ecosystem processes in a temperate, eutrophic estuary (Neuse River Estuary, North Carolina). During the droughts, dissolved inorganic nitrogen concentrations were on average 46–68% lower than the long-term mean due to reduced riverine input. Phytolankton productivity and biomass were slightly below average for most of the estuary during a spring–fall drought in 2002, and were drastically lower than average throughout the estuary during a fall–winter drought in 2007–2008. Droughts affected upper trophic levels through alteration of both habitat condition (i.e., salinity, dissolved oxygen) and food availability. Bottom water dissolved oxygen levels were near or slightly above average during the 2002 drought. Concomitant with these modest improvements in bottom water oxygen condition, fish kills were greatly reduced relative to the long-term average. Low oxygen bottom water conditions were more pronounced in the latter stages of the 2007–2008 drought, and mesozooplankton abundances were 8-fold lower in summer 2008 than during non-drought years. Below average mesozooplankton abundances persisted for well over one year beyond cessation of the drought. Significant fish kills were observed in summer 2008 and 2009, perhaps due to the synergistic effects of hypoxia and reduced food availability. These results indicate that droughts can exert both ephemeral and prolonged multi-year influence on estuarine ecosystem processes.

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THE IMPORTANCE OF USING MULTIPLE METHODS TO ANALYZE BIOGENIC MINERALS IN FISH OTOLITHS FOR UNRAVELING LIFE HISTORY COMPLEXITIES

Reconstructing the timeline of fish migration through otolith analysis (in-situ chemical analysis) provides a critical tool for understanding the complex life histories of anadromous American shad. American shad in their introduced range (U.S. Pacific coast) have shown greater plasticity in life history strategies than in their native range, which may account for their successful colonization and abundance in the Columbia River, WA. The USGS Columbia River Research Laboratory found that intermediate-sized, one and two year old American shad were present in the Columbia River above Bonneville Dam, but little was known about them. We assumed these fish were year-round residents within the reservoir. To test this assumption, we used an electron microprobe to determine the strontium/calcium ratios along an otolith transect corresponding to a timeline from hatch to capture. We expected low levels of strontium across the otolith transect, reflective of exclusive freshwater rearing. The resulting strontium/calcium transects had some unexpected strontium peaks, indicating that these fish may have migrated to the ocean for a short period and returned to Bonneville Reservoir (235 km) via a fish ladder. Since this scenario seemed unlikely and violated our assumptions about the migration capabilities of juvenile shad, we needed to go further by: 1) validating the ocean migration theory using an alternate analysis method, 2) identifying an alternate freshwater source of strontium or 3) proposing an alternate mode for strontium incorporation (i.e. stress). To do this, we re-analyzed the otoliths for trace elements (barium, strontium, and calcium) and strontium isotopes. By using several methods for analyzing the in-situ chemical composition of otoliths, we were able to challenge our assumptions and answer questions about this unusual life history variant of American shad.
Tidal marshes that are vital to the overall health of the Delaware Estuary are eroding rapidly. The Delaware Estuary Living Shoreline Initiative (DELSI) was designed to evaluate the ability of various shellfish restoration and enhancement methodologies to restore and protect tidal marshes. A secondary but related goal was to broaden the range of tactics available to strengthen overall ecosystem services throughout the Estuary through shellfish restoration and enhancement. Several factors contribute to tidal marsh loss in the Delaware Estuary including erosion associated with sea level rise and widespread degradation and conversion of interior areas to open water. Finally, human development along the marsh-upland interface prohibits inland marsh migration. One technique that may help marshes keep pace is to protect vulnerable shorelines with natural structures like shellfish reefs which buffer marshes from wave action, thereby slowing erosion and buying more time for marshes to accumulate in place (vertical accretion) or move inland (horizontal relocation). The principal focus of this practitioner’s guide is to describe mussel based living shorelines as one useful shoreline stabilization method in the Delaware Estuary. Our findings from the Delaware Estuary Living Shoreline Initiative (DELSI) indicate that this tactic may be useful under certain circumstances. The guide provides information on where mussel based living shorelines might work and how to implement a mussel based living shoreline. As designed thus far, the DELSI treatment is a promising alternative to bulkheading or the placement of rip-rap. More substantial tactics, however, are needed in high energy locations. This practitioners’ guide describes each step of the process for creating a mussel based living shoreline from site selection and design to installation methods to monitoring. The permitting process and costs are also discussed and will hopefully aid future living shoreline project planning.

SALT MARSH EROSION CONTROL AND ENVIRONMENTAL ENHANCEMENT IN THE MID-ATLANTIC

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PRACTITIONER’S GUIDE TO SHELLFISH-BASED LIVING SHORELINES FOR SALT MARSH EROSION CONTROL AND ENVIRONMENTAL ENHANCEMENT IN THE MID-ATLANTIC

As a result of interactions among these factors the mode of Phragmites expansion has changed. Improved understanding of the relationship between habitats and physical (e.g., tidal, topographic, and geomorphic) gradients. At larger spatial scales, we found that habitats were arranged within distinct landscapes with different associated ecological functions. Improved understanding of the relationship between habitats and physical processes and how habitats were arranged together aids development of large-scale ecosystem restoration design principles and target metrics that address expected future changes.

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SPATIAL CHANGES IN SEDIMENT RESUSPENSION IN A SMALL ESTUARINE SYSTEM

Two sites in the New River near Jacksonville, North Carolina have been continuously monitored since summer 2008 using Autonomous Vertical Profilers (AVPs). The AVPs currently provide a nearly continuous time-series of vertical profiles of optical turbidity among other water quality parameters as well as wind velocities via on-board anemometers. During a four month period of time from Aug-Dec 2009 two Acoustic Doppler Current Proﬁlers (ADCPs) were deployed coincidently with the AVPs. The up-estuary site is situated in Morgan Bay in about 8-10 feet of water where the tidal influence is small. The tide contributes about 25% of the water velocity variability. The second site is located mid-estuary in Stones Bay in about 6-8 feet of water. The tidal influence in Stones Bay is considerably higher, contributing approximately 50% of the variability in velocity. Based on the AVP data, an algorithm was developed to objectively identify sediment resuspension events. High turbidity events were observed on average about five times per month in Morgan Bay and roughly 40 times per month in Stones Bay. Events in the more tidally influenced Stones Bay were often coincident with the tidal flow maximum. These resuspension events would last anywhere from a couple of hours to days. The wind data and the concurrent ADCP deployments were used to elucidate some possible causal mechanisms for the resuspension events including tidal shear stress and wind/wave stress. The continuous vertical profiles allow us to characterize the temporal and vertical distributions of resuspension events. Sediment resuspension in Stones Bay tends to be a mix of both vertically homogenous and bottom dominated events, whereas in Morgan Bay events are nearly always vertically homogenous. The difference between these two environments illustrates how the relative magnitudes of the physical drivers can dramatically change the frequency of sediment resuspension all within the same small estuarine system.
MEASURING NUTRIENT FLUX IN PACIFIC COAST SALT MARSHES USING FLUCTUATING WATER-LEVEL CHAMBERS

Nutrient removal from the water column is an important ecosystem function that contributes to the production of clean water, a final valued ecosystem service of wetlands. However, little data is currently available for nutrient exchange in Pacific Northwest tidal ecosystems. We have identified a method that will help to quantify nutrient flux for multiple tidal wetland habitat types, which when coupled with areal cover of the habitats and estimates of inundation duration, can be used to estimate landscape-level nutrient removal rates. This technique, a modification of the method developed by Chambers (1992), utilizes fluctuating water-level nutrient flux chambers that inundate enclosed patches of marsh habitat with artificial seawater at the same rate and water depth as occur in the surrounding wetland. Water of known nutrient concentration is delivered to the chamber as the incoming tide increases pressure on an external collapsible reservoir and is drawn back out as the tide recedes and reduces pressure. We demonstrate that the hydraulic head pressure created by the incoming and outgoing tide will successfully equilibrate chamber water levels to within approximately 3 cm of ambient levels and that water losses/gains from the system are minimal, typically less than 0.01% of the initial reservoir volume. Preliminary results from experimental chambers deployed in vegetated low marsh sites of Yaquina Bay, OR in early spring indicate uptake rates of about 5 μmol m⁻² d⁻¹ for PO₄, 20 for NO₂⁻/NO₃⁻, and 10 for NH₄, though considerable within- and between-site variability exists.

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BENTHIC NITROGEN FIXATION: AN AUTOCHTHONOUS SOURCE OF NITROGEN TO THE NEW RIVER ESTUARY, NC

Nitrogen (N) has been shown to limit primary production in many estuarine systems, including the New River Estuary (NRE), NC, a moderately eutrophic system with large areas of photic sediment. The NRE receives large inputs of allochthonous nutrients from agriculture and confined animal feeding operations. Autochthonous sources of N in the NRE include both remineralization and N-fixation. Whereas allochthonous sources are usually most important in winter/spring and during periods of high fresh water discharge, autochthonous sources are likely to become more important in summer. N-fixation, which can be performed by both autotrophic cyanobacteria and heterotrophic bacteria, is likely to vary in response to light availability and temperature. To assess the importance of N-fixation at a system-wide scale we sampled seasonally along the estuarine gradient at multiple water depths (with a range of light availabilities) and multiple sediment depths. To determine the relative contributions of autotrophic and heterotrophic N-fixers to the benthos, surface samples were incubated in both the light and dark. Molecular characterization of the microbial communities along with the molybdate inhibition technique were used to verify the relative importance of autotrophic to heterotrophic sulfate reducing N-fixers. N-fixation activity was determined using the acetylene reduction method. There were no significant differences in N-fixation between light and dark incubations, suggesting the importance of heterotrophic N-fixers at these sites. Although highest rates of N-fixation were in the top 0–1 cm, a substantial portion occurred down to 10 cm. N-fixation rates were highest in the mid and lower sites during summer, with estimates as high as 2407 μmol N m⁻² d⁻¹. Preliminary estimates show that N-fixation may be a significant source of autochthonous N to the NRE, contributing up to 21% of total inputs during summer.

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ASSESSING THE ECOLOGICAL AND HUMAN HEALTH STATUS OF BALTIMORE’S INNER HARBOR

Baltimore’s Inner Harbor and its watershed is a highly urbanized area in the mid-Atlantic region of the United States. The city of Baltimore was founded in the 1700s, with the population spreading out into adjacent lands over the last three centuries and continuing to expand into suburban and exurban areas today. This study assessed water quality and biotic parameters as ecological health indicators of Baltimore’s Inner Harbor and its watershed. Bacteria and trash were assessed as human health and aesthetic indicators. Assessment of each indicator is based on methodologies validated through peer-reviewed scientific articles and years-long development of indicators for assessing the health of Chesapeake Bay via the Chesapeake Bay Program. Each indicator is compared against a threshold value and scored on a 0-100% scale, which is a gradient from Very Poor to Good health. The study found most water quality indicators to be either poor or very poor in the Inner Harbor. Additionally, the bacteria and trash levels in the Inner Harbor were rated as poor. The watershed health was better than the Inner Harbor receiving waters, with water quality indicators and bacteria scoring from good to poor. Lack of spatial and temporal coverage of basic water quality data in the Inner Harbor was a major hindrance to accurately assessing its ecological health. Future plans to remedy these problems, such as expansion of citizen science monitoring, will be discussed. This study is a component of the Waterfront Partnership of Baltimore’s Healthy Harbor Initiative, which describes sustainability and restoration goals as well as an implementation plan that will restore the health of Baltimore’s Harbor.

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CONTRIBUTION OF CULTURAL EUTROPHICATION TO MARSH LOSS IN JAMAICA BAY (NY)

Loss of salt marsh area in the Jamaica Bay Estuary (NY) has accelerated in recent years, with loss rates as high as 45 acres per year. A contributing factor to this acceleration is likely cultural eutrophication due to over 6 decades of sewage effluent inputs. We examined marsh soils for an eutrophication signal using stable nitrogen isotope ratios and radiometric dating in Jamaica Bay. A noticeable increase in the stable nitrogen isotope ratio was observed in the soils beginning in the 1850s corresponding with an increase in people settling in the surrounding watersheds. Both human population and stable nitrogen isotope ratios increased until the 1930s, which coincided with the initiation of sewage treatment operations in the Jamaica Bay watersheds. Significantly higher soil respiration rates were measured at the disappearing Black Bank marsh compared to the stable JoCo marsh. In addition, Black Bank soils were sapric (more decomposed), and had significantly higher bulk densities and lower organic matter than JoCo. Significant loss of roots, rhizomes, and organic matter was also observed in the deeper soils at the Black Bank marsh. These data suggest that salt marsh losses in this system may in part be a result of loss of belowground peat and support the idea that the marshes are deteriorating from the bottom up, with subsidence and ponding contributing to marsh loss. A 9-year record of accretion, elevation, and shallow subsidence from JoCo and Black Bank will be reported and examined with the belowground structure results. With the additional stress of climate change (e.g., accelerated sea level rise, increases in storm and precipitation events), eutrophication effects in northeastern United States urbanized areas may cascade into even more accelerated losses of marsh areas.

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LONG TERM PATTERNS OF SEASONAL WATER DEPTHS AND IMPACTS ON APPLE SNAILS AND SNAIL KITES IN THE EVERGLADES

This preliminary study examines associations between hydrologic history and trends in Apple Snail (Pomacea paludosa) populations and Snail Kite (Rostrhamus sociabilis)
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THE BALANCE BETWEEN DIFFERENT CONTRIBUTIONS TO THE DIN POOL IN DETERMINING PHYTOPLANKTON BLOOMS IN NORTHERN SAN FRANCISCO ESTUARY

Primary production and phytoplankton bloom development are controlled in large part by the interplay of available nutrients. Traditionally the concentration of elements (e.g. N as dissolved inorganic nitrogen) has been considered rather than evaluating new and different chemical forms of the elements affect the nutrient dynamics. It is known that phytoplankton respond differently both in physiology and species competition in systems dominated by NO3, NH4 or both. For example, in the northern San Francisco Estuary (SFE) NO3 and NH4 co-occur, with NO3 making up the majority of the DIN. Elevated NH4 prevents phytoplankton from using NO3 due to the well described inhibition phenomenon. However, for phytoplankton blooms to develop, the pool of NO3 must be accessed. As a result, few phytoplankton blooms have been observed in the SFE over the last decade because mean NH4 concentrations remain inhibitory for phytoplankton NO3 uptake. Two spring phytoplankton blooms have been observed, the first in 2000, when chlorophyll concentrations reached 35 μg/L, in parallel with low NH4 and rapid phytoplankton NO3 use. The second occurred in 2010, with chlorophyll concentrations of 35 μg/L along with low NH4 concentrations and substantial NO3 drawdown. The mechanism responsible for the low NH4 in 2010 appeared to be a combination of freshwater dilution and reduced NH4 discharge from a large wastewater treatment plant. Although the total DIN concentrations were similar in the SFE during bloom and non-bloom years, the contribution of NH4 to the DIN pool varied substantially and played a role in determining bloom development. The typical NH4-rich DIN that characterizes the northern SFE likely contributed to food limitation in higher trophic levels by lowering the quality and quantity of food of the pelagic food web. This would have not been observed by looking at elemental stoichiometry of N alone.

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PHOSPHATE MANAGEMENT AND INCREASED TIDAL RANGE

The Lower St. John’s River is an estuarine system with a typical estuarine salinity gradient. The systems catchment is characterized as agricultural, high-density residential, industrial, and urbanized. Not unlike other blackwater coastal plain rivers, the St. John’s receives pollutant loads that alter the natural character of both sediment and water quality. Phosphate loads, sourced to residential and agricultural activities, contribute to increased frequency and intensity of cyanobacteria blooms which destabilize aquatic communities and compromise water quality. In some cases, freshwater wetlands serve as a net-sink for phosphate from surrounding drainage. This assessment analyzes the variation in phosphate content of riparian wetland soils at depth and along the St. John’s River salinity gradient. Manipulation of natural hydrology is ongoing in the St. John’s River, primarily due to the permitted surfacewater withdrawals for water treatment facilities in Seminole County, FL and deepening of the federal navigation channel in Jacksonville, FL. Due to these, and quantified sea-level rise data on the system, this study provides information for realistic nutrient management and understanding the role of increased salwater on sediment phosphate flux.

Three sites have been established in an effort to quantify total and pwave phosphorus. Site one is located at Sixmile Creek and represents a tidal-freshwater swamp. Site two has been established as the transitional community, located at Goodby’s Creek. A saltmarsh adjacent to Sister’s Creek was selected for site three.
THE ANNUAL CYCLE OF MIXING IN AN INTERMITTENT ESTUARY

Intermittent estuaries are common in Mediterranean climates such as California. In these systems, longshore sand transport closes the mouth of the estuary during low freshwater flow conditions prevalent in the dry summer season—eliminating tidal exchange between the estuary and the ocean. In spite of their presence along the length of the California coast, as well as in Australia, South Africa and Brazil, the mechanisms of transport and mixing in intermittently-open estuaries have not been fully defined. To address this short-coming, we have pursued a year-long comprehensive data collection effort focused on the Pescadero-Butano estuary and watershed on the Central California coast. As would be expected, the dynamics of mixing and transport in the estuary are strongly influenced by the state of its mouth. In fall, when the mouth is closed, the adjoining marsh complex slowly floods and winds are the dominant source of mixing energy, but the estuary remains strongly stratified by salinity. In early winter, when the mouth breaches, the estuary undergoes an energetic transition to the open state. During the breach, vertical mixing of the estuary frequently leads to fish kills, which seem to be sensitive to the nature and extent of the stratification in the estuary at the time of the breach. In the open state, hydraulic flows through the estuary and mouth interact with oceanic conditions (tides, storms, swells) to determine the mixing environment. Ocean swell and swell-induced ocean set-up contribute to estuarine mixing at a level comparable to the tides. In this talk, we present this annual cycle and discuss the implications for stratification and conditions in the estuary.

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ASSESSING THE ECOLOGICAL HEALTH OF CHESAPEAKE BAY

Several methods that combine a variety of ecological indicators are currently used to estimate the health status of Chesapeake Bay. One of the most quantitative methods available has been used recently to evaluate health-related water quality and biological indicators both individually and combined as indices in order to elucidate regional patterns of improving and worsening trends since 1986. Using this method, dissolved oxygen, chlorophyll-a, and Secchi depth were analyzed separately and further averaged to create a Water Quality Index (WQI); similarly, the phytoplankton and benthic indices of biotic integrity (P-IBI and B-IBI, respectively) and the area of submersed aquatic vegetation (SAV) were analyzed separately and averaged to create a Biotic Index (BI). The WQI and BI were subsequently averaged to create a Bay Health Index (BHI). Although regional trends of these indicators are informative, they commonly mask important and sometimes contradictory dynamics observed at smaller scales. Despite restoration efforts that have reduced nutrient and sediment loading to Chesapeake Bay in some areas, the water quality and biotic indicators evaluated at smaller scales using this method have generally shown little improvement since 1986. Worsening trends commonly observed with several of these indicators and other metrics indicate that chronic eutrophication has resulted in a progressive loss of important ecosystem functions over the last two decades.

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STEMMING THE TIDE OF INVASIVE SPECIES

Non-native species introduced to novel habitats by humans are known as “invasive species” if they can or do cause ecological or economic harm. Well over 250 non-native species have been introduced to bays, coasts, and marine environments in the U.S., primarily through boating and shipping activities and aquaculture, but also as live seafood and bait and through the aquarium trade. The best means to stem the tide of invasive species is to prevent them from being introduced in the first place; once a non-native species is established, it is costly and difficult to eradicate. Public awareness campaigns have been successful at raising awareness about this problem and some simple solutions that everyone can support.

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DETERMINING THE TOXIC, BENEFICIAL AND NO EFFECT ENDPOINTS OF A COMMERCIALY-AVAILABLE SOIL AMENDMENT FOR COASTAL PLANT RESTORATION APPLICATIONS

Humic acid is a soil conditioning agent that has been employed to enhance the quality of marginal soils for agricultural applications by increasing nutrient availability and soil organic matter, among other properties. Currently there are few studies that examine the efficacy of using humic acid to improve plant growth in coastal environments. Given the typically poor quality of the substrates where many coastal restoration efforts are needed, as well as the high costs of these efforts, the evaluation of soil conditioning agents to improve planting success is warranted. The effect of nutritive elements and compounds on organisms can generally be described as a dose-response relationship, with no effect, beneficial, and toxic responses occurring as the concentration of the nutritive elements or compounds increases. Thus, a key step towards the effective employment of emerging restoration technologies that use novel soil amendments is determining the range of doses at which the optimal effects occur for critical species. In this study, we assessed the responses of plant species that are crucial to the restoration of a range of barrier island habitats in Louisiana, including Uniola paniculata and Panicum amarum (dune), Distichlis spicata, Paspalum vaginatum and Spartina patens (swale) as well as Spartina alterniflora and Avicennia germinans (back-barrier salt marsh) to humic acid application in a greenhouse setting. A general trend of no effects below 100 ml m⁻², beneficial effects from 100 ml m⁻² to 900 ml m⁻², and deleterious effects at 2,700 ml m⁻² and above was elucidated for most species examined. In particular, P. amarum and P. vaginatum demonstrated increased biomass with moderate humic acid application. Large-scale field investigations are currently underway to assess the efficacy of this soil conditioning agent in barrier island dune, swale, and back barrier marsh habitats as a component of a restoration project.

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STERIC CONTRIBUTIONS TO SEA LEVEL RISE: A GLOBAL PERSPECTIVE

In the globally-averaged sense, modern day sea level rise can be caused by either addition of heat or freshwater to the global oceans. Global sea level rise caused by the addition of heat is known as thermosteric sea level rise. Because the oceans absorb the vast majority of oceanic heat trapped by anthropogenic greenhouse gases, quantifying this heat is central to understanding the net human-induced forcing of the climate. A review of recent estimates of global thermosteric sea level rise will be presented, along with an updated estimate of thermosteric sea level rise and its regional variability since the late 1990s. An assessment of the most recent global sea level budget will also be presented. On regional scales, both temperature and salinity changes can drive changes in sea level. Upper ocean steric changes account for the majority of the regional patterns of global sea level, and estimates of these will be compared with satellite observations of regional sea level change as well.

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THE EFFECTS OF VARIABILITY IN TIDAL FORCING ON GROUNDWATER EXCHANGE IN COASTAL WETLANDS

Tidal fluctuations are an important driver for groundwater flow in coastal wetlands; in turn, groundwater flushing can strongly influence nutrient exchange and salt marsh productivity. We used numerical models and field observations to quantify changes in groundwater discharge caused by variations in tidal forcing, specifically changes in mean water level and tidal amplitude. Models show that groundwater exchange over a tidal cycle increases as the mean water level rises, provided that the rise in mean water causes more of the marsh platform to be inundated at high tide. Once the marsh is fully inundated at high tide, further increases in mean water level cause groundwater exchange to decrease. Larger tidal amplitudes cause greater groundwater exchange than smaller amplitudes. Field observations from Sapelo Island, GA, show variations in groundwater exchange of as much as a factor of twenty during a short tidal cycle. Large, short-term increases in mean water level caused by storm surge temporarily “drowned” the marsh, reducing groundwater discharge at the creekbank by 50%. Results suggest that tidally-driven groundwater exchange in coastal systems is highly variable over short (storm surge, spring-neap) periods. This exchange is also affected by seasonal and inter-annual variations in sea level. Furthermore, small increases in mean water levels associated with sea level rise could increase groundwater flushing, and thus productivity and nutrient exchange, in marshes that are equilibrated near mean high water, but rising sea level could decrease productivity, and thus accretion rates, in marshes that are equilibrated lower in the tidal frame.

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THE EFFECTS OF CRAB BIOTURBATION ON MID-ATLANTIC SALTMARN TIDAL CREEK EXTENSION: GEOTECHNICAL AND GEOCHEMICAL CHANGES

Understanding saltmarsh response to recent sea-level rise is critical for management and mitigation of these valuable coastal areas, yet comprehensive studies that include biological, geological, and hydrodynamic interactions that create changes to the marsh landscape in the face of rising water levels are rare. This study analyzes ecophysical feedbacks from crab colonization and bioturbation on geotechnical and geochemical properties of the soil in a Mid-Atlantic saltmarsh experiencing creek extension due to accelerated sea-level rise. Measurements of redox potential, pH, belowground biomass, and soil strength reveal that intense crab bioturbation significantly changes the biogeochemical properties of the soil. Oxidized conditions in the upper 10-20 cm of the marsh induced by burrowing crabs
enhanced degradation of Spartina alterniflora belowground biomass (roots and rhizomes, reduction from 1850 ± 651 g/m2 to 764 ± 302 g/m2), which reduces the structural integrity of the soil. This process ultimately increases the potential for sediment in creek head areas (documented by a reduction in shear strength from 14 ± 9 kPa to 2 ± 1 kPa), facilitating creek extension and accommodation of tidal flows. The pervasiveness of similar tidal creek morphology in southeast Atlantic saltmarshes suggests this is a ubiquitous process for marshes with a moderate tidal range undergoing sea-level rise.

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USING HIGH-FREQUENCY ACOUSTICS TO MONITOR OXYGEN EVOLUTION IN THALASSIA TESTUDINUM, HALodule WRIGHTII, AND SYRINGODIUM FILIFORME

The use of high-frequency acoustics has recently gained momentum as a viable method for mapping the areal coverage of seagrasses. The free gas contained within the aerenchyma of the seagrass leaves and the bubbles produced during photosynthesis cause scattering and absorption of acoustic energy. This results in an observed acoustic signal that is clearly distinguishable from the signal associated with bare substrates. Since the bubbles produced by seagrasses are partly responsible for the observed acoustic signal, we hypothesized that changes in the rate of primary production will alter sound propagation throughout a seagrass canopy. To test this hypothesis, we examined the propagation of high-frequency sound energy through the canopy of three species of seagrass in a shallow outdoor mesocosm. Relative changes in the received acoustic energy were recorded every hour during a 24-hour period and compared to independently-measured rates of oxygen production. We observed a decrease in the received acoustic energy coinciding with an increase in oxygen production during daylight hours and an increase in received energy during periods of respiration. These results illustrate the potential of using high-frequency acoustics as a non-invasive measure of primary production in submerged macrophytes.

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COASTAL LAND-USE, GROUNDWATER, AND SURFICIAL SALT MARSH MORPHOLOGY: PRELIMINARY RESULTS FROM A PILOT STUDY IN GOULDSBORO, ME

Groundwater links terrestrial, coastal ecosystems with the nearshore, ocean environment. In salt marshes, groundwater investigations tend to focus on two broad areas: (1) field and modeling studies that consider the hydrology of upland transitions or tidal exchange effects, or (2) ecosystem-level effects of groundwater-transported, land-derived nutrients and contaminants to the nearshore system. In form, salt pools (shallow, water-filled depressions common to north-temperate salt marshes) resemble open-water features from other landscapes, like flarks found in northern peatlands. In peatlands, studies show that groundwater plays an important role in the maintenance of flarks, yet no previous work examines the role of groundwater in the creation or maintenance of open-water features in salt marsh environments. In 2008, we installed shallow (about 1 m depth) and deep (about 2.5 m depth) groundwater wells equipped with 30 cm long screens in 14 locations in Grand Marsh, Gouldsboro, ME to investigate how groundwater flow paths relate to surficial pool morphology, specifically pool necks (distinct, elongate, open-water features that extend from the main pool body). Hydraulic potentials indicate that horizontal movements of shallow and deep groundwater generally align with measurements of neck orientation and that vertical flow paths reveal up-welling of shallow groundwater to open-water features, suggesting a connection between groundwater and the surficial expressions of pool and neck morphologies. While provocative, our study is data-limited and only the first step toward understanding potential groundwater control of open-water features in northern salt marshes. Still, the connection between terrestrial coastal systems, groundwater, and salt pools has important implications for the capacity of salt marshes to cope with mounting environmental stress and is one example of a human-geological legacy effect influencing north-temperate coastal settings.

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WAVELET ANALYSIS OF SYNOPTIC VARIABILITY IN TAMPA BAY, FL

Wavelet analysis is used to investigate the link between the El Nino Southern Oscillation (ENSO) and local synoptic variability in Tampa Bay from 1950-2006. Hourly sea level elevations were obtained from the St. Petersburg tide gauge (8926520). Wind speed and direction were obtained from three different sites (Albert Whitted Airport, Tampa International Airport, and MacDill Air Force Base) from NOAA's National Climatic Data Center. The hourly averaged u- and v-components were calculated. The amplitudes of the wavelet transform of sea level elevation and wind components are averaged over periods of 2 to 20 days (to isolate the synoptic scale). Anomalies of the data and NOAA's Oceanic Niño Index were obtained by removing the monthly climatology, and then were used to calculate seasonal averages (SA). During winter, spring, and summer the SA of the u-component of the winds during El Niño (La Niña) is negative (positive). During the fall El Niño is positive and La Niña is close to 0. During neutral years the SA is close to 0. The SA of the u-component of the winds during El Niño (La Niña) is positive (negative) in the winter, spring, and fall and negative (positive) in the summer. The SA of the elevation follows a very similar pattern to the SA of the u-component of the winds, showing a correlation between elevation and the u-component of the winds. Relative strengths of the SA for elevation and u- and v-component of the winds are also quantified.

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FLUID MUD MOBILITY BY TIDAL PUMPING

As a result of ongoing deepening, the Ems in Germany/Netherlands developed from a regular estuary with moderate turbidity maximum at the head of salinity intrusion into a...
hyperventilation with system containing 40 km of fluid mud well beyond the salinity intrusion, moving with the tidal excursion. Sediment concentrations within this fluid mud layer amount to 30–40 g/l. Winterwerp (2011) argued that this development took place in three phases: - weak feed-back between enhanced gravitational circulation and reduced river flushing, - strong feed-back in a transient phase due to internal tidal asymmetry in vertical mixing, - very strong feed-back yielding a new stable state owing to asymmetries in peak velocity.

This paper investigated how the stable phase 1 state is maintained by tidal pumping. As the fluid mud layers are thick, consolidation times exceed the tidal time scale. During accelerating tide, longitudinal pressure gradients accelerate the fluid mud to high velocities (~1 m/s). The turbulent suspension entrains water from the upper part of the water column diluting the fluid mud layer every ebb and flood phase, compensating for consolidation around slack tide. When diluted, and mixed over the water column, the almost Newtonian suspension is easily transported by the tide, obeying asymmetries in peak velocity. The interface rising with accelerating tide is illustrated in a series of multi-frequency echo soundings in the river. Initially, internal waves on the fluid mud – water interface occur, followed by a rising of the interface rises, which eventually disappears when the mud becomes well mixed over the water column. Towards slack water, the suspension settles fast owing to rapid flocc formation, and the cycle of settling/consolidation and tidal pumping is repeated, tide after tide. Brunes and Winterwerp (2011) showed that such entrainment can be simulated properly with a state-of-the-art k-ε turbulence model, allowing quantification and prediction of these processes.

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USING FOOD NETWORK MODELS TO UNDERSTAND ECOSYSTEM EFFECTS OF GREEN CRAB MITIGATION STRATEGIES

Food network models quantify the mass and energy flows among trophic components, and are useful tools for predicting outcomes of biological and physical perturbations in ecosystems. We developed a network model for the intertidal sand flat in the Kejimkujik Seaside Lagoon to understand potential ecosystem effects of a current green crab mitigation program. Model inputs of biomass, production, consumption, and diet composition for each living or non-living compartment were obtained through field collection or relevant literature. Dynamic simulations that modeled effects of no crab fishing, fishing 50% of crab biomass, and fishing 90% of crab biomass on ecosystem components were conducted. Network analyses indicated that removal of green crabs caused only slight perturbations to overall ecosystem growth and development, as measured by total system throughput and ascendency. Measures of community energetics, such as total system biomass and productivity, were also only slightly perturbed by crab removal. Despite the robustness of the overall ecosystem, direct effects of crab removal on certain ecosystem components were evident. Major crab predators, such as gulls, decreased in biomass with fishing effort. Diet switching of gulls to other prey types did not compensate for lost crab biomass. Predators that overlapped in diet with crabs, such as plovers, increased in biomass with fishing effort, because prey were more abundant when released from intense crab predation. While the relatively resilient intertidal sand flat ecosystem prevented drastic ecosystem alteration when crabs were removed, direct effects of crab fishing on energy flow among trophic components remained important and require further study.

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CHANGES IN SEDIMENT CHARACTERISTICS IN THE SEMI-ENCLOSED GEUNSO BAY, WEST COAST OF KOREA

The western tidal flats of Korean Peninsula are widely developed due to relatively large tidal ranges (max. 9 m). The sedimentary processes on the tidal flats are directly influenced by monsoons, resulting deposition and/or erosion of sediments. Geunso Bay in the mid-west of Korea is a semi-enclosed bay with a mean tidal range of about 6 m. Digital elevation model showed that 95% of the total area of the bay was tidal flat. In order to understand seasonal variations of sediment characteristics on Geunso tidal flat, sedimentary analysis and monitoring sedimentation rates were conducted. The surface sediments in the bay consisted of mainly muddy sand and were classified into five sedimentary facies in winter and summer 2009. The sedimentation rates were determined by burying a plate at sub-bottom depth and periodically measuring the changes in depth between the surface and plate. In the eastern tidal flat, the annual sedimentation rates were determined by subtracting the plate buried at sub-bottom depth at the same location at the beginning and end of the observation period. The erosion was dominated on the middle part of the tidal flat, while the deposition on the western tidal flat during winter and spring with the net deposition rate of 10.8 mm/year. The suspended sediments were supplied relatively a large amount into the bay in winter and spring and were transported in anti-clockwise direction. Sediment transport paths were calculated using grain-size parameters of the surface sediments in winter 2009. The resultant sediment transport pattern showed relatively predominant westward transport vectors in the tidal flat. The winter wave played a limited role in the seasonal variation of sedimentation due to the southwestwardly opened bay mouth. It seems that the supply of suspended-sediments is most important for seasonal variation of sediments on the tidal flat. The net sedimentation showed that the deposition occurred in the western tidal flat and the erosion occurred in the middle and eastern tidal flat of the bay.

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THE UTILITY OF CONCEPTUAL ECOSYSTEM MODELS FOR THE DEVELOPMENT OF A RESEARCH AND MONITORING PROGRAM AT THE GRAND BAY NATIONAL ESTUARINE RESEARCH RESERVE

Conceptual Ecosystem Model (CEM) methods have been used as the foundation of an integrated assessment and ecosystem management protocol at the Grand Bay National Estuarine Research Reserve and National Wildlife Refuge (hereafter GBNERR), two protected areas in southeastern Mississippi. Conceptual Ecosystem Model methods combine scientific data with management constraints to create tools for evaluating cause-effect relationships and potential risks for an ecosystem, as well as guide management decisions. In addition to scenario forecasting, these models can be used to identify data and knowledge gaps, provide focus on valued ecosystem components (VENCs), and prioritize research/monitoring needs. The GBNERR CEM identifies 28 environmental stressors and their source, highlights VECs in 19 key habitats, and provides assessment and measurement endpoints. The modeling effort highlighted unanticipated insights into the function of the GBNERR ecosystem. For example, unlike more classic riverine-dominated estuaries, discussions during the model development suggested this system is a marine-influenced system. Thus, stressors such as climate change and sea-level rise were hypothesized to have a greater long-term impact on the system, whereas eutrophication would have a lesser impact. Based on results of the GBNERR CEM, research needs and data gaps identified in the Reserve’s Site Profile, areas of staff expertise and opportunities for collaboration, reserve and refuge staff have now identified and developed six broad focus areas for research/monitoring efforts; these include (1) ecological effects of sea level rise, (2) ecology of tidal marsh vertebrates, (3) ecology of unique habitats, (4) monitoring ecosystem effects of mercury, (5) coastal plant ecology and mapping, and (6) long-term monitoring of environmental conditions. Discussions of current GBNERR research and monitoring efforts will highlight the utility of the CEM approach to conserve estuarine ecosystems.

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LABORATORY INVESTIGATIONS OF MARINE CRUSTACEAN BEHAVIORAL RESPONSES TO ELECTROMAGNETIC FIELDS

The emerging field of renewable ocean energy is challenged with a wide range of permitting issues, including understanding and mitigating for potential environmental impacts on coastal marine life. Through a series of laboratory studies, we are investigating the effects of electromagnetic fields (EMF) on a range of potentially susceptible marine life, including bottom-dwelling invertebrates and fish. Little is known about the behavioral or physiological responses of these organisms to EMF; or what the cumulative impact of multiple devices might be. We will present results from initial and on-going experiments that examine behavioral responses of Dungeness crab and American lobster to a simulated EMF source in the laboratory. We have used the antennular flicking rate of the crab as one target measure of a detection response to EMF and as a detection response to olfactory cues after EMF exposure. Avoidance/attraction behaviors to EMF of crab and lobster under varied conditions of prey and refuge availability are also being examined. Results from these studies as well as those planned for the future will be discussed as they relate to permitting issues.

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Abstract Book

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NEKTON SPECIES DISTRIBUTION AND ABUNDANCE WITHIN AND AMONG FOUR OREGON ESTUARIES

Crabs, shrimps and fishes provide valued ecosystem goods and services to communities of the Pacific Northwest, including species that are fished for food and recreation and those that serve as prey for fished species. In the face of increasing use of these services and potential threats to their productivity (i.e., climate change, water pollution), it is essential to understand the distribution of nekton on both local and regional scales so that their productivity may be better estimated. Two-tide sampling surveys were conducted at >20 stations in intertidal channels in each of four Oregon estuaries (Tillamook, Yaquina, Alsea, and Coos) using a 3-m-wide plumb-staff beam trawl; depth, temperature, and salinity were also measured at each station. Species’ densities were calculated from abundance and area-sweep; lengths of abundant species were measured. Preliminary analyses reveal that species richness followed a log-normal distribution, with only two or three dominant species at each site, and that biodiversity decreased with distance from the estuary mouth. Dungeness crabs (Cancer magister) had the highest density in Coos Bay, whereas sand shrimps (Crangon spp.) had the highest densities in Yaquina, Alsea, and Tillamook estuaries across all samples combined. English sole (Parophrys vetulus) was the most abundant fish in all four estuaries. Biodiversity and population densities of C. magister and P. vetulus were weakly positively correlated with salinity and temperature, while the population distributions of Pacific haddock scomber fish (Leptocottus armatus) and sand shrimps were more evenly dispersed across salinity and temperature gradients. Future analyses will examine whether intertidal habitat type and area are better predictors of nekton diversity, distribution, abundance, and biomass.

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THE EFFECTS OF EXCEPTIONAL DROUGHT CONDITIONS ON ESTUARINE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE GUADALUPE/SAN ANTONIO BASIN, TEXAS

The supply of freshwater to estuarine ecosystems is a critical factor in maintaining the overall health and organization of coastal marshes. Specifically along the Texas Gulf coast, the coupled effects of decreased freshwater inflows to the estuary (e.g., freshwater extraction) and natural processes (e.g., precipitation, wind, and tides) can exert significant salt-stress on coastal marsh ecosystems. The overall impact of decreased freshwater inflow is currently highlighted as the region is in the midst of significant and prolonged drought – with no short-term end in sight. Here we present coastal marsh salinity and water level data from various coastal habitat types including: connected-, isolated-, and intermittently connected-ponds, tidal creeks, and inland marshes. We also examine past estuarine inflow patterns from the period of record to gauge the severity of the current drought, as compared to previous low inflow years. The broader application of these inflow and salinity data is in determining how marsh habitat quality and food availability is influenced during the current high stress/high salinity conditions. The coastal marshes of the ANWR are home to a wintering population of endangered Whopping Cranes (Grus americana), which feed on blue crabs (Callinectes sapidus) and wolfberry (Lycium caroliniaum) fruit during their time at ANWR. Both of these food items have been shown to have significant responses to salinity patterns and can also be impacted by water flow/water level (e.g. lack of water may physically restrict access to pond habitats). Through determining how surface water salinity and connectivity varies along the marine to upland transect (this includes in tidal creeks, connected-, isolated-, and intermittently connected-ponds, and high/inland marsh) both researchers and managers can make more well informed decisions to better manage the ecosystem and improve overall habitat quality.

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THE EFFECTS OF SALINITY PULSES ON THREE FRESHWATER SAV SPECIES

Freshwater and oligohaline submerged aquatic vegetation (SAV) provide habitat and improve water quality in estuaries. Salinity is a major determinant of SAV species ranges, but is highly variable due to storm surges, dam releases, and droughts. This study examines the effects of salinity pulses and the rates of salinity increase on Hydrilla verticillata, Heteranthera dubia, and Vallisneria americana. Various metrics of plant morphology and metabolism are compared to determine the effects of stress. The effects of salinity stress were found to increase water stress in the salinity pulses. H. verticillata was highly sensitive to salinity, with stress evident at levels as low as 3 PSU, and mortality was observed at 10 PSU for exposure times of a week or greater. H. verticillata growth was reduced after a one-day pulse at 10 PSU followed by a 28 day recovery period, with mortality after a one day pulse at 15 PSU. In repeated salinity pulses where salinity was raised to different levels for one week followed by one week of fresh water, little recovery between pulses was seen. Salinity tolerance of V. americana was found to be greater than that of the other two species. The results of this study will help to improve our understanding of the relationships between varying freshwater inflows and SAV species responses. This will be useful for the modeling and management of freshwater inputs into estuaries. As climate changes, the frequency and intensity of droughts and storms may increase, causing salinity to become more variable, and the effects of pulsed salinity must be considered in the planning of SAV restoration efforts.

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BELOWGROUND DECOMPOSITION AS THE MECHANISM BEHIND SURFACE ELEVATION LOSS IN DITCHED MARSHES

Loss of surface elevation makes salt marshes more susceptible to impacts from accelerated sea level rise, such as vegetation die-off, and conversion of marsh to open water. The degradation of salt marsh systems has ramifications ranging from loss of habitat for waterfowl and fish to loss of a buffer from storm surges. A more comprehensive understanding of the mechanisms driving surface elevation loss in anthropogenically altered and degraded marshes is key to engineering successful marsh restoration projects. This study aims examine processes controlling surface elevation in areas of salt marsh with high man-made ditch density through comparison of the hydrologic, sedimentary, and vegetative conditions of a non-ditched portion of salt marsh. It is hypothesized that a decrease in hydroperiod through increased drainage, characteristic of areas of high ditch density, results in significantly longer periods of lower water table levels allowing for increased oxygen diffusion into the subsurface causing increased belowground decomposition to occur. This leads to a reduction in organic matter, and without compensation from an inorganic sediment supply, marsh subsidence occurs. Belowground organic decomposition was measured using a litterbag technique at which live roots and rhizome material was buried at a 30cm depth in two salt marsh sites in Parker River NWR for periods of 3 and 6 months. This was supplemented by comparisons of belowground biomass data as well as % organic content. Water table levels were monitored simultaneously using a traditional water level well coupled with a water level data logger for more frequent sampling intervals. The study quantifies relationships between hydroperiod, drainage, and belowground decomposition, which are likely to be causing local surface elevation loss.

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BENEFITS FOR HUMANS AND HABITATS: EXAMPLES OF SUCCESSFUL CORAL, OYSTER REEF AND ANADROMOUS FISH HABITAT RESTORATION AT ECOTOMICALLY MEANINGFUL SCALES

A primary challenge for ecosystem restoration is demonstrating ecologically meaningful outcomes at various scales. Documenting the social and economic benefits of restoration is equally challenging, and no less important. Since 2001, more than 100 projects in 22 states and territories have been supported through a public-private National Partnership between The Nature Conservancy (TNC) and the National Oceanic and Atmospheric Administration’s (NOAA) Restoration Center. This Partnership has demonstrated that coastal habitats can be restored with innovative approaches and collaborative local partnerships that promote community involvement and stewardship. Such projects laid the foundation for the scaling up of restoration actions and better documenting outcomes using standardized performance measures. The American Recovery and Reinvestment Act (Recovery Act) passed by the U.S. Congress provided NOAA with $167 million for mid-scale habitat restoration projects. Many Recovery Act funded coastal restoration projects, including removal of marine invasive algae, restoration of threatened staghorn and elkhorn corals, oyster reef and sea grass habitat and watershed-based restoration for anadromous fish, are dramatic expansions of restoration work that began as proof-of-concept scale community-based projects. These projects also bring increased focus to metrics pertaining to social and economic outcomes, such as creation of jobs in communities that are experiencing economic challenges. Each of these projects have well defined ecological, sociological and performance goals and scientific monitoring plans that demonstrate the promise and challenge of taking restoration to regional scales. This presentation will highlight how several of these projects are providing an important framework for restoring threatened species and U.S. coastal habitats. Examples of the ecological benefits of projects that have completed implementation to date will also be discussed.

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INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE INFLOW PATTERNS AND COASTAL MARSH SALINITY IN THE
APPLICATION OF A COUPLE LAKE SCALE AND NEARSHORE WAVE-CURRENT COUPLED MODEL TO SIMULATE THE NEARSHORE DYNAMICS

It is known that nearshore and coastal water is the important region in Great Lakes or ocean. Unlike the coastal ocean, the lake circulation significantly influences the nearshore and coastal circulation. Because of the complex geometry of coastline, a high-resolution unstructured grid model is required for the nearshore region, however it would be time-consuming if applying a high-resolution model outside the interesting area or in the whole lake. Additional local phenomena (e.g., wave) are also needed be included in the nearshore or coastal model and it us additional time to simulate these processes using the lake scale model. So an accurate couple lake and nearshore model is highly required for the Great Lakes or coastal ocean. The nesting system between the low-resolution lake model and nearshore high-resolution one using the Finite Volume Coastal Ocean Model (FVCOM) successfully improves the hydrodynamics simulation. Based on the lake scale and local scale coupled model system, the effect of the wave to the nearshore circulation is investigated. It is widely known that currents are influenced by wave primarily by way of surface wind stress, radiation stress, and bottom stress. This complex physical process also challenges the scientist and requires additional works, FVCOM was coupled with the FVCOM-SWAVE to answer this need in nearshore Grand Haven, MI. The effect of waves on nearshore circulation was simulated at the nearshore Grand Haven region with the help of the ADCP data. Also the individual and coupled effects of the river discharge, waves, and ambient flow on the nearshore circulation are discussed and summarized here. River discharge and ambient flow have little influence on the nearshore circulation, but they interplay with the wave forcing at the coast. It was found that among the processes that wave effects present to the system, radiation stress and current-wave interaction are more important than wave-induced bottom stress.

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COMPARATIVE STUDIES OF HYPOXIA MODELING IN THE CHESAPEAKE BAY AND NORTHERN GULF OF MEXICO

The depletion of dissolved oxygen in coastal and estuarine waters has been increasing in frequency and intensity in recent decades. Hypoxia results from complex interactions between physical and biogeochemical processes and causes stresses in the marine environment. The causes and remediation of this widespread phenomenon has drawn much interest. Its coincidence with eutrophication has also spawned management debates and has a profound influence on management decisions. Well-tested numerical simulation models are between physical and biogeochemical processes and causes stresses in the marine environment. Its coincidence with eutrophication has also spawned management debates and has a profound influence on management decisions. Well-tested numerical simulation models are.

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EFFECTS OF LIGHT REDUCTION ON THE RECOVERY OF PHYSICALLY DISTURBED SEAGRASS BEDS

Coastal development, maritime and port activities, and dredging operations are some of the anthropogenic disturbances that shallow coastal seagrass habitats are exposed to. In addition to increasing turbidity, which reduces light available for photosynthesis, activities such as dredging physically removes seagrasses en masse from the seabed. The effects of light reduction and recovery from physical disturbance and removal have both been examined (separately) but no studies have tested the ability of seagrasses to recover from physical disturbance in a reduced light environment. This experiment examines the recovery of experimentally created gaps in two seagrass meadows in Singapore under two shading regimes. Gaps of 30cm × 30cm were excavated and subjected to two shading treatments (moderate shading of ~40% surface irradiance, SI, and high shading of ~20% SI) and an open control. Physical recovery was determined by the density of shoots within the 30cm × 30cm gaps measured at fortnightly and monthly intervals. Results indicate that light reduction plays a role in the rate of recovery of gaps in seagrass beds with significant differences between control and treatment plots. Seagrass meadows with predominantly pioneer species such as Halophila ovalis and Halodule uninervis recover more quickly from physical disturbance under light-reduction treatments than meadows with climax species such as Thalassia hemprichii and Enhalus acoroides.

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PHASE 5.3 WATERSHED MODEL ACCURACY ASSESSMENT METHODS

The Total Maximum Daily Load (TMDL) program drives water quality policy and management today. Field monitoring and computer models are the two methods available for tracking pollution and assessing the effectiveness of a TMDL developed for improving water quality. Field monitoring is the most direct method but also the most expensive and it is spatially and temporally variable. On the other hand, models can save time and resources and provide a synthesis and framework for monitoring and research findings. Mathematical models are powerful tools for simulating watershed processes and management on water resources. Mathematical models used in TMDLs require assessment methods in terms of the seasonal oxygen depletion. The strength and issues of different hydrodynamic models and different configurations of oxygen-regulating processes will be identified and discussed. The results will provide guidance in building up ecological forecasting capabilities at NOAA.
accuracy of simulated data compared to measured flow and pollutants. The Phase 5.3
Chesapeake Bay Watershed Model, an application of the Hydrologic Simulation Program-
Fortran (HSPF), is one of a group of environmental models used to develop the Chesapeake
Bay TMDL. The objective of this study is to quantify and visually summarize the Phase 5.3
Model performance when simulating streamflow, nutrients, and sediment. Target plots,
histograms, and cumulative distribution functions graphs are used to explore mathematical
relationships between statistical metrics in order to display model performance. The general
model evaluation guidelines developed by Moriasi et al. (2007) are used to judge model
performance in watershed simulations. The target diagram approach and Normalized Bias
and Root mean square difference metrics described by Jolliff et al. (2009) are also used.
Simulated stream flow from 195 river segments were compared with observed data. The
evaluation results indicate that 83 % of river segments had a very good performance, 13 %
a good performance, 3 % a satisfactory performance and 2 % an unsatisfactory performance
when simulating streamflow. The lack of sufficient observed data can cause an
unsatisfactory performance and this was found only in small river segments.

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MORPHODYNAMICS AND CONCEPTUAL MODEL OF SEASONAL
OPENING/CLOSURE INLET IN TROPICAL COASTAL LAGOONS, MEXICO:
MANAGEMENT IMPLICATIONS

Tropical coastal lagoons (TCL) are shallow fresh/brackish marine low-lying coasts separated
from the ocean by a barrier island, spit, reef, or sandbank and connected at least
intermittently to the sea by one or more restricted tidal inlets. TCL rank among the most
productive ecosystems, and they provide a wide range of ecosystem services and resources
as well as attractive areas for artisanal fishery, salt production, and tourism development.
The seasonal environmental physiological cycle for Paramo Lagoon (Jalisco, Pacific coast of
Mexico) is described following the conceptual ecological model as Period-1:
disconnected from the sea, evaporation is much higher than freshwater input and salinity
reach 75 psu. Period-2: disconnected from the sea, freshwater input is much higher than
evaporation and salinity drop to 5 psu. Period-3: the inlet is open connecting the lagoon with
the ocean showing optimal estuarine conditions and salinity 23 psu. This cycle is discussed
proposing a comprehensive conceptual model to understand natural environmental impact,
resilience, and recovering. From an ecosystem-based management approach we conclude
that habitat response under extreme variability is modulated by geomorphology, tidal range,
and strong seasonal freshwater budget because of climate variability.

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A MODELING STUDY OF THE EFFECT OF TIDE ENERGY EXTRACTION ON
ESTUARINE CIRCULATION AND ITS IMPLICATION TO THE CHANGE OF
MARINE ECOSYSTEMS

Recent growing interest in developing in-stream tidal energy generation has raised concerns
about the effects of tidal energy extraction on estuarine and coastal physical processes and
the marine ecosystems dependent on those processes. There are few direct observations of
the effect of energy extraction on living systems; however our understanding of the
magnitude and importance of these effects can be enhanced through analytical, experimental
and numerical analyses at the appropriate temporal and spatial scales. This paper presents a
numerical modelling study to simulate in-stream tidal energy extraction and assess its effect
on the circulation and mixing in a tidal dominated estuary using a three-dimensional (3D)
unstructured grid finite volume coastal ocean model. A tidal turbine module is incorporated
into the hydrodynamic model using a momentum source/sink approach. The tidal turbine
module is applied to simulate the tidal energy extraction in an idealized tidal bay and
estuarine system. A series of numerical experiments are carried out to assess the effects of
tidal energy extraction on the total volume flux, velocity distribution, salinity stratification
and mixing within the bay. The implication of changes in physical processes due to tidal
energy extraction on water quality, the marine food web and the ecosystem is also discussed.
EFFECTS OF THE DEEPWATER HORIZON OIL SPILL ON ECOSYSTEM SERVICES: THE INTERIM REPORT FROM THE NATIONAL RESEARCH COUNCIL

In order to evaluate the loss of ecosystem services in the Gulf of Mexico Large Marine Ecosystem due to the Deepwater Horizon Mississippi Canyon-252 spill, it is necessary not only to collect and analyze information related to specific types of services, but also to identify relationships among the lost ecosystem services and assess interdependencies. The interim report from the National Research Council’s Committee on the Effects of the Deepwater Horizon Mississippi Canyon-252 Oil Spill on Ecosystem Services in the Gulf of Mexico addresses the following: 1) The methods that are available for identifying and quantifying various ecosystem services at meaningful spatial and temporal scales. 2) The methods and types of information that can be used to approximate baselines (but-for-the-spill) for distinguishing effects on ecosystem services specific to the spill. 3) The types of valuation methods that are appropriate for measuring ecosystem services over time with regard to recovery under the following approaches: natural processes, mitigation, and restoration efforts.

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TURNER DESIGNS’ FLUOROMETRIC INTEGRATED NAUTICAL MAPPING SYSTEM (C-FINS)

Recently and primarily due to technological advancements, undersea mapping of in vivo fluorescence in aquatic habitats has shown to be a powerful tool for researchers looking to spatially resolve phytoplankton distribution within one, or across multiple, systems. Once configured, the fluorescence signal from an in situ fluorometer capable of data output is captured using mapping software that tags each incoming data point with GPS coordinates. Using these data a high resolution map is drawn showing changes in phytoplankton abundance relative to the fluorescence signal as measured by the in situ fluorometer. Turner Designs’ Fluorometric Integrated Nautical mapping System (C-FINS) utilizes a C3 Submersible Fluorometer for fluorescence detection so users can map multiple parameters simultaneously. C-FINS was used to map CDOM, Chlorophyll, and Turbidity through Elkhorn Slough, a tidally influenced seasonal estuary located near Moss Landing, California, in an effort to determine how changes in CDOM and Turbidity affect phytoplankton abundances. As expected, there were significant increases in CDOM and Turbidity fluorescence near the landward end of the slough, away from the oceanic end. Surprisingly, the chlorophyll fluorescence also increased significantly near the landward end of the slough indicating a large phytoplankton abundance in the high temperature, low visibility waters found in the slough. A large benefit to using C-FINS for this type of surveys is that time can be efficiently used to make multiple passes to better document and record, and possibly help explain, these kinds of observations.

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EXPANSION OF THE INVASIVE DWARF EELGRASS, ZOSTERA JAPONICA, IN YAQUINA BAY, OREGON

The areal coverage of the non-indigenous dwarf eelgrass, Zostera japonica, is increasing in several estuaries on the U.S. West Coast. As a result, regulatory agencies in the states of California and Washington are considering methods of controlling its expansion. Factors relevant to this effort are specific zones of an estuary where Z. japonica gains a foothold and the rate at which it expands its range. Here we describe the results of a decade-long study of the spatial distribution of dwarf eelgrasses in Yaquina Bay, USA. The method used was classification of digital orthophotographs obtained during aerial photography surveys with false color near-infrared film, conducted during daytime low tides in the spring and summer growing seasons. A comparison of classification and ground survey results for dwarf eelgrass cover vs. bare substrate yielded an overall accuracy of 83%. In Yaquina Bay this invasive eelgrass first appeared in the upper intertidal zone and gradually moved downslope over the years. Highest cover densities initially were found near small streams of freshwater runoff, suggesting that this source may be important to its establishment. Estimates of the rate of spread of dwarf eelgrass in lower Yaquina Bay are presented.

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APPLYING NORMATIVE THEORY TO INFORM MANAGEMENT INDICATORS AND STANDARDS FOR SNORKELING AND SCUBA DIVING IN THE FLORIDA KEYS

Resources managers are directed by institutional mandates having both ecological and social components, so it is important to determine how people will respond to both real and perceived changes in reef conditions and management strategies. In 2006 the Florida Reef Resilience Program (FRRP) posed the question, “what do people want and need from coral reefs?” This research employs normative theory to investigate snorkeler and SCUBA divers’ views on acceptable levels of use and reef resource condition. A sample of snorkelers and divers was identified through in-person intercepts, conducted every month from June 2006 – July 2007. Participants were sent a mail survey, implemented using the Dellman (1978) Total Design Method. The overall response rate for divers and snorkelers was 57.9%. This analysis focuses on non-resident respondents with a sample size of 938 divers and 558 snorkelers. Respondents were asked to describe the number of divers, snorkelers and boats they considered to be acceptable to see, and how many they observed, in order to create acceptability norm curves. Respondents were also asked about their perceptions of crowding. In order to identify norms related to acceptable reef condition both divers and snorkelers were asked to rate the acceptability of four coral reef characteristics: coral bleaching, algal cover, visibility and fish distribution. In general, respondents experienced only a small perceived level of crowding and experiences were in line with expectations of seeing other resource users. Snorkelers and divers indicated similar levels of acceptability regarding reef condition; 25% bleached reef, 25% algal cover, 20 feet of visibility and a balanced number and variety of fish types. The question of what people want and need from coral reefs is a social question; these goals and preferences along with biological and ecological considerations should be the basis of coral reef management decision-making.

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WOODBRIDGE CREEK, NEW JERSEY SALT MARSH RESTORATION - YEAR ONE MONITORING

The 17.5-acre Woodbridge Creek salt marsh (WCSM) restoration project was selected by NOAA to serve as partial compensation of injured natural resources associated with the 1990 Exxon Bayway Oil Spill. Pre-construction monitoring at the Woodbridge Creek site was conducted in September of 2000 and 2001. Restoration activities were completed in June 2007 and consisted of sediment/soil excavation, removing tidal restrictions, Phragmites australis removal, and vegetation planting, predominantly Spartina alterniflora. Post- restoration field monitoring of surface water quality, flooding depth/duration, porewater salinity/sulfide, vegetation community structure, soil characteristics, and nekton utilization of tidal creeks is being conducted during two non-consecutive years; 2010 and 2012. Results from the first year of post-construction monitoring indicate that vegetation communities are meeting pre-established success criteria, with greater above-ground biomass, greater diversity and a more even distribution of species than that of a nearby reference site. Average tidal flooding duration at the restored marsh was 20.8%, markedly greater than the average duration observed at the reference site (8.8%). Average porewater salinity was significantly higher at the reference site located downstream of the restored marsh, yet mean porewater sulfide concentrations did not differ significantly between the two marshes. While both marshes receive adequate salinity to support sulfate reduction, porewater sulfide may be relatively high at the restored marsh because its lower elevation and more frequent inundation support higher rates of sulfate reduction. The restored marsh also appears to support greater abundance and species richness of nekton than the reference site; lower elevation provides greater access to the flooded marsh surface and dense emergent vegetation provides nursery habitat and refuge from predation for juveniles and forage species.

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CMES: A TOOL FOR UNIFYING HABITAT CLASSIFICATIONS FOR A GULF OF MEXICO TROPHIC DATABASE

The diet of an organism is in large part influenced by the habitat in which it resides or that of its feeding grounds. An effort is underway to catalogue the dietary data of fishes and other taxa for the Gulf of Mexico from literature sources. In many cases, habitat information is

Societies, Estuaries & Coasts: Adapting to Change

Abstract Book

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included in the reference material or it can be inferred from the study. But these data are in varying degrees of detail, clarity and consistency. Furthermore, until recently, no comprehensive and standardized classification for estuarine and marine habitats existed. We report on a pilot study using the Coastal and Marine Ecological Classification Standard (CMECS) to unify the habitat information for dietary studies of fishes in the Gulf of Mexico. CMECS first classifies a habitat into a system, i.e. estuarine, marine, or lacustrine, and then uses any of the five components (Benthic Biome Component, Water Column Component, Geoform Component, Sub-Benthic Component, Surface Geology Component) to add further detail to the classification based on data available or the purpose of the study. We classified habitat information from approximately 420 out of over 700 food habits references from the detail to the classification based on data available or the purpose of the study. We classified (CMECS) to unify the habitat information for dietary studies of fishes in the Gulf of Mexico.

**Habitat Suitability Index Models**

Habitat suitability index (HSI) models are used widely to investigate how species distributions may change under different management or climate change scenarios. Important management decisions may be based on model results, often without a clear understanding of the level of uncertainty associated with model outputs. We examined possible changes in submerged aquatic vegetation (SAV) due to sea level rise and hydrologic restoration, and developed an integrated approach to assess the propagation of uncertainty from model inputs on model outputs (global uncertainty analysis; GUA); and relative importance of uncertain model inputs and their interactions on the model output uncertainty (global sensitivity analysis; GSA). We illustrate the GSA/GUA framework using HSI models for multiple species of SAV in southwest Everglades National Park, including: Vallisneria americana (tape grass), Halodule wrightii (shool grass), and Thalassia testudinum (turtle grass). Primary model input was provided by the BISECT hydrologic model developed to project hydrologic changes that may result from different scenarios of sea level rise and restoration. Uncertainty for each species was estimated and presented in the form of uncertainty maps and probability distributions for selected locations. The main controlling factors (uncertainty sources) for each species were identified and the contribution of each factor to model uncertainty was quantified. The most important factors controlling HSI response for high-salinity-tolerant species were light-related, while salinity-related factors were most important for freshwater species. The uncertainty maps show where uncertainty is highest and which location-specific factors should be measured or estimated more accurately to reduce HSI uncertainty in the most effective way. The formal evaluation of HSI models by

GSA/GUA may provide additional useful information that can be incorporated into decision support tools for natural resource management.

**Abstract Book**

**21st Biennial Conference of the Coastal and Estuarine Research Federation**

**Hydrodynamic and Water Quality Model of the Loxahatchee River and Estuary: A Management Tool**

Loxahatchee River and Estuary on the southeast Florida coast has long been affected by freshwater diversion to control flooding. A related impact has been partial conversion of Cypress swamps to mangrove wetlands as salt intrusion into the upper estuary increased after freshwater diversion. In an effort to better manage this system the EFDC/HEM3D hydrodynamic and water quality model was applied as a management tool to simulate hydrodynamics, salinity regime and water quality conditions. Measured time series of water level and meteorological processes were used to drive and calibrate the hydrodynamic portion of the EFDC model. Water quality calculations produced by the companion eutrophication model were coupled to the water quality results of a watershed model to establish a capability for testing management alternatives in the Loxahatchee watershed. Calibration of the hydrodynamic and water quality simulations were based on a comparison of predicted and measured data from the Loxahatchee River. Calibrated Hydrodynamic and transport predictions show that the salinity regime of the Loxahatchee River is characterized by strong seasonal cycles related to freshwater inflows. Salinity intrusion can reach more than 13 km above Jupiter Inlet during the dry season. Conversely, during extended periods of high freshwater inflows, freshwater can dominate the Loxahatchee River to within 5 km of Jupiter Inlet. In addition to seasonal cycles of the salinity regime, shorter variations in salinity occur over period of a week to 60 days. These variations are likely to be linked to a combination of secondary fluctuations in freshwater inflows and meteorological forcing that can influence water levels. The calibration and validation of the hydrodynamic and salinity predictions indicate that EFDC can be used to accurately assess the potential benefits of freshwater management alternatives.
also tested in our present study as a comparison. The variation in toxicity of these compounds among different salinity is also addressed in this study.

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ACUTE TOXICITY OF SURFACTIN, FA-GLU AND COREXIT TO LARVAE OF GULF KILLFISH, FUNDULUS GRANDIS

The increasing application of dispersants in oil spill events has caused public concerns about their impact on the environment. A quest for “green” dispersants, which are produced from agricultural wastes, effective, non-toxic and biodegradable, has become more urgent since the BP oil spill in 2010. Surfactin is a powerful biosurfactant and can be produced by engineered strains of Bacillus subtilis. It has shown high efficiency in oil dispersal, but its agricultural wastes, effective, non-toxic and biodegradable, has become more urgent since the BP oil spill in 2010. Surfactin is a powerful biosurfactant and can be produced by engineered strains of Bacillus subtilis. It has shown high efficiency in oil dispersal, but its...
the ocean, are important for threatened and endangered juvenile salmonids and other biota. Recent efforts to create a database of wetland site characteristics in this region have produced new data on tidal marsh channel characteristics. In this presentation, we will compare marsh channels from historical and created sites that occur in three different hydrologic regimes: Lower Estuary, Energy Minimum, and Tidal River. We collected channel morphology and hydrology data at 35 marshes between Bonneville Dam and the mouth of the Columbia River over six years. From these data, we have developed baseline information for tidal marshes including structural morphology and inundation regime. We will present information for a subset of these marshes in an effort to answer two hypotheses: 1) channels within historical tidal marshes change longitudinally through the river system and hydrologic regimes, and 2) the channel morphology of created marshes differs from natural marshes. This information has the potential to inform current conservation and restoration planning about how marsh channel characteristics may change through a system and could lead to investigations into the importance of those differences for habitat.

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MAINE TIDAL POWER INITIATIVE: FISH INTERACTIONS WITH A COMMERCIAL-SCALE MARINE HYDROKINETIC DEVICE

The Maine Tidal Power Initiative (MTPI) is taking a comprehensive approach to understanding the development of tidal power. Research directions include turbine performance, the physics of wake effects, risks to fish, and social dimensions. Research since 2009 has focused on the Ocean Renewable Power Company’s tidal generating device. Since fish are a key part of the marine ecosystem likely to be affected by marine hydrokinetic devices a major focus of the initiative has been environmental assessments to assess impact. Two main objectives since 2009 have been (1) to collect baseline information on vertical distribution of fish in the water column in identified areas for deployment and (2) to observe full-scale pre-deployment testing of the device using two DIDSON acoustic imaging systems, mounted fore and aft of the device. For the latter, data were collected day and night for 24 h periods during multiple seasons. In total, more than 200 h of footage were collected: 158 h with the turbine in the water (122 moving and 35 still), and 50 h with no turbine present (mainly in February). The sampling periods covered current speeds of up to 2.5 m s⁻¹ (5 knots) and a wide range of environmental conditions. Fish behavioral responses to the turbine were quantified to understand how fish will respond to this marine hydrokinetic device. Given the poor visibility in this tidally dynamic area and the need for both day and night observation, the DIDSON proved to be a useful tool for the device assessment. In conjunction with these data, baseline vertical distribution data collected at proposed deployment and control locations (May, June, August and September of 2010 and 2011) are used to understand the relationship between fish behavior and fish presence at proposed deployment depths. The sustainability science approach and integration efforts across MTPI projects will be discussed.
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