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Elevating the Science and Practice of Restoration

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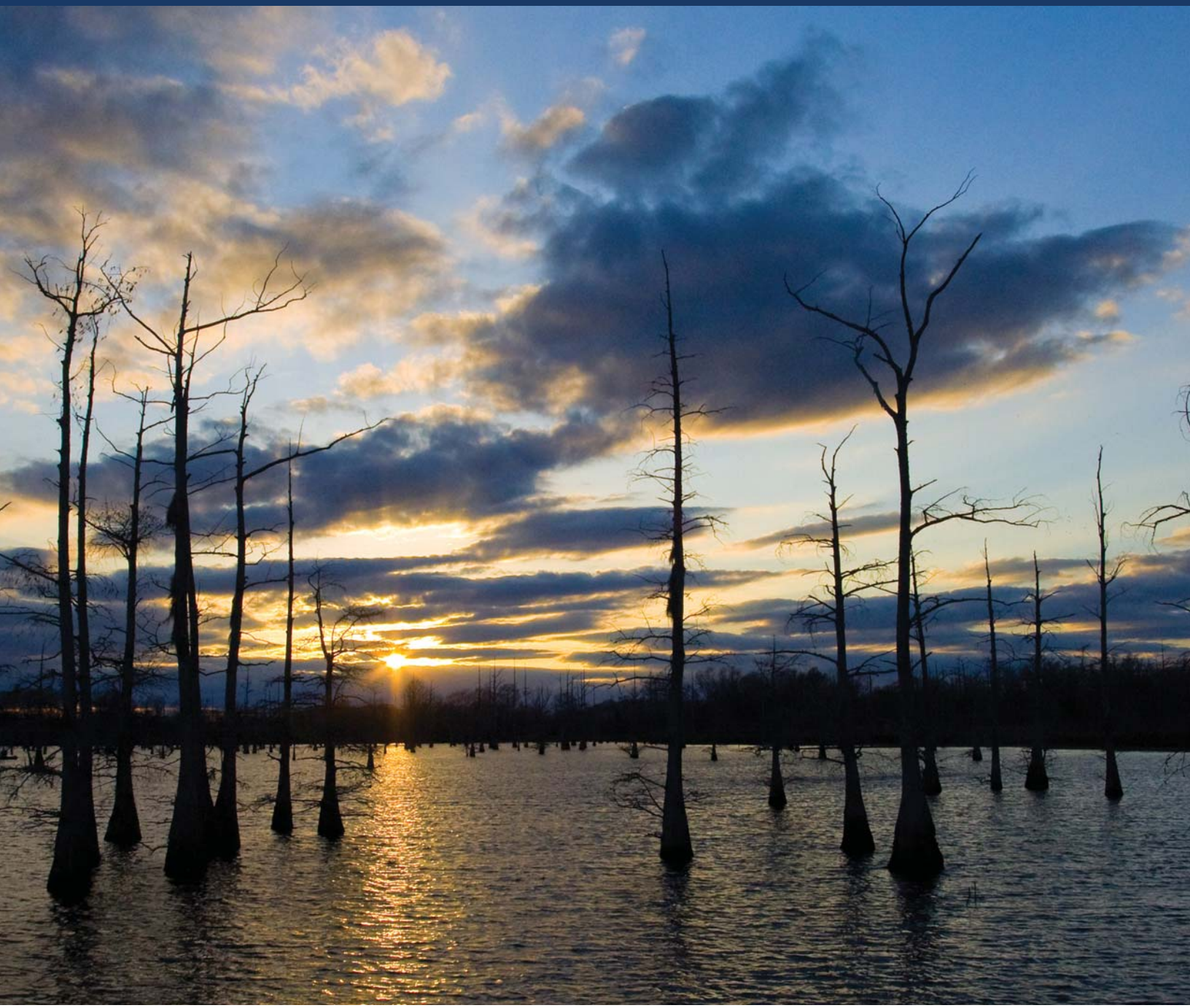
July 28-August 1, 2014 | New Orleans, LA USA



SER SOCIETY FOR ECOLOGICAL RESTORATION

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CEER 2014

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Conference Abstracts

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BEYOND REMEDIATION: DESIGNING AN ALTERNATIVE LANDFILL COVER FOR HABITAT RESTORATION AND CARBON SEQUESTRATION IN AN INDUSTRIAL CORRIDOR

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Roux Associates worked with the BASF Corporation to transform a nine-acre industrial landfill into a diverse educational ecosystem at an 80-acre former chemical manufacturing facility adjacent to the Hudson River in Rensselaer, New York. The alternative cover incorporates both phytotechnology and native species to attain equivalency with state landfill closure regulations, and also provides valuable habitat for native wildlife and migratory birds. The proximity of the site to an urban center provided a unique opportunity to involve the local community by providing a living demonstration of environmental remediation and ecological restoration.

Pre-design studies were conducted to determine species survival under site-specific conditions, and to evaluate whether bioaccumulation of landfill waste occurred in planted species. Results demonstrated the ability of the hybrid poplar and native willow cultivars to stabilize the landfill contaminants and minimize translocation into aboveground portions of the plants. The full cover design included strategically placed phytotechnology plantings in a variety of habitats, including meadow, shrub forest, and wetlands, which were all planted with native species. The landfill cover was designed to balance precipitation and evapotranspiration, while directing runoff into vegetated drainage swales to minimize or eliminate infiltration into landfill waste, and demonstrate equivalency to conventional landfill cap requirements.

Roux Associates assessed the carbon sequestration potential of the habitat by conducting a carbon footprint analysis of the remediation activities. By incorporating woody species in the landfill closure and habitat creation design, the results of the analysis indicated that the landfill will attain a net zero carbon footprint.

By linking ecological restoration and green remediation strategies, BASF was able to maximize the ecosystem services within a highly urbanized area and return a former industrial landfill into an ecological refuge that is beneficial to both the community and the environment.

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ASSESSING THE CURRENT CONDITION OF DAMAGED ECOSYSTEM – CASE STUDY FOR UMM NEGGA SITE IN THE STATE OF KUWAIT

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The world's largest hydrocarbon spill, and one of the worst environmental disasters in history, occurred as a result of Iraq's invasion and occupation of Kuwait in 1991. Multiple ecosystems in Kuwait were impacted and contaminated by these spills and associated military activities. As compensation, Kuwait was awarded over $460 million USD to restore its damaged terrestrial ecosystems and four locations were approved as future protected areas, yet each is currently damaged and restoration needs to be planned. The central objective of our study is to assess and understand the current condition for Umm Nigaa location in order to design a restoration plan. We sought to assess the impact of land cover change in the protected area using remote sensing products in order to understand the history of the site and to determine the driving forces for the damage. We also sought to assess the current condition of the ecosystem damage in the location by estimating the potential soil loss, through soil samples and field reconnaissance. We also sought to select the optimum locations for re-vegetation using specific criteria, since financial resources will allow only 30% of Umm Nigaa to be planted and initially watered. As a part of the overall restoration effort, the re-vegetation of damaged ecosystems will be critical in stabilizing the desert surface, possible enhancement of the distribution of rainfall, ensuring the continued viability of multiple endangered species, providing sustenance for endemic wildlife, and alleviating the desertification and land degradation affecting the livelihoods of people and their well-being. Ultimately, the study could also be applicable to the restoration of other damaged similar ecosystems in the future.

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RESTORING GREAT WATERS AND NATIONAL PARKS FOR THE 2ND CENTURY OF THE NATIONAL PARK SYSTEM – A NATIONAL OVERVIEW

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The health of the national parks around the Gulf of Mexico is directly linked to the health of the entire Gulf. There are nine national park units in the Gulf region that are integral to the region's natural systems and economic and cultural fabric. According to the National Park Service (NPS), in 2011, these national parks attracted more than 9 million visitors who contributed nearly $540 million to local economies. The disaster that was the Deepwater Horizon explosion and subsequent oil spill is providing unprecedented opportunities to restore lands in and around national parks as well as acquire and restore land for future park units. With the nine existing national parks around the Gulf Coast and the possible additions of the Lone Star Coastal National Recreation Area in Texas and the Mobile-Tensaw Delta in Alabama, efforts are underway to ensure that a portion of the BP penalty fines are used on projects that benefit national parks with a goal of recovering from the oil spill and improving the overall health of the Gulf. By viewing the entire Gulf as one large ecosystem, we can look at ways to improve the health of places like Galveston Bay, Mobile Bay, and Florida Bay, which support vibrant fisheries, wildlife habitat, and livelihoods throughout the Gulf region.

This session will explore opportunities for protecting, restoring, and growing the national parks around the Gulf Coast leading up to the National Park Service's Centennial in 2016 and ensuring the parks' viability and relevance beyond 2016. It will highlight activities taking place at Everglades National Park and Gulf Islands National Seashore and discuss opportunities to expand the national park system in Texas and Alabama. There are a variety of restoration and preservation projects – either proposed or underway – that have goals of recovering from the oil spill disaster and improving the overall health of the Gulf of Mexico to allow it to be more resilient in the future.

The Great Waters Program at the National Parks Conservation Association works to restore the nation's most iconic waterways for the benefit of national parks and the millions of people who live around and visit the parks each year. NPCA focuses on the Everglades, Gulf of Mexico, Great Lakes, New York/New Jersey Harbor, Chesapeake Bay, Colorado River, and other waters to strengthenrestoration efforts and federal policies and programs. NPCA co-chairs the America's Great Waters Coalition, an alliance of national, regional, state, and local organizations working to protect, preserve, and restore our nation's Great Waters. The Coalition is a result of years of work by organizations to bring the broader restoration community together to "raise all boats."

With nine out of ten Americans having visited a national park, more Americans should learn about restoration efforts taking place around the Gulf Coast through the lens of national parks. NPCA provides a voice for Americans in these efforts to ensure that national parks are protected and restored and are appropriately available for recreation and interpretation.

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RIPARIAN TUGAI VEGETATION RESTORATION ALONG THE TARIM RIVER IN NORTHWEST, CHINA IN THE CONTEXT OF APCOCYNUM

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The most productive ecosystems in Central Asia belong to the riparian vegetation along the rivers in the region called Tugai vegetation which is consisted of *Populus euphratica, Tamarix ramosissima, Glycyrrhiza inflate,Halimodendron halodendron ,Phragmites Australis,Apocynum venetum* and ect.. Tugai vegetation which is only green belt between Talamakan desert and Tianshan mountain is not only home to sprawling oasis with rich culture, but also harbors many plant and animal species in Tarim basin. It also alleviates desertification and sand storm and insures smoothness desert high way. In the Tarim Basin, the oases area was enlarged from the 1950ties onward leading to the complete desiccation of the Lakes Lop Nor and Taitema, the former end-lakes of the Kenqi and Tarim River, respectively. In both basins, the lower reaches of the rivers turned into episodical river courses or fell dry completely. Under those conditions the natural riparian vegetation and the irrigation agriculture, especially along the lower reaches, suffered and suffers water shortage leading the degradation and economic losses, respectively. Along with the enlargement of irrigation area and periods of water shortage, soil salinization has become a major concern for farmers in the area. Therefore restoring basic ecosystem services of Tugai landscape is critical to controlling sand storm and long term sustainability of the area. Due to vast land reclamation along the Tarim River in Xinjiang, Northwest China to grow cotton, native plant species are facing a severe competition for water which is essential for their survival. This talk introduces main ecosystem services of *Apocynum* and its potential substitution with cotton and its impact on restoration of Tugai vegetation landscape which is critical to oasis ecosystem.

The two species *Apocynum venetum* and *Apocynum pictum* are distributed in Central Asia and China. *Apocynum venetum* and *Apocynum pictum* are perennial plants, which roots are perennial, while the stems die every year. Thus, *Apocynum venetum* and *Apocynum pictum* grow under the arid climate of Central Asia and provide utilization options without irrigation. Fully restored Apocynum species would serve as essential part of Tugai vegetation landscape.

Finally in this talk, Investigation results of overall above and below ground biomass, and its water use efficiency measured by potential evapotranspiration and economic utilization of Apocynum the will be presented and compared to cotton derived from multidisciplinary approach used in this study. Restoration recommendations will be made for Tugai vegetation in this region.

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ADAPTIVE MANAGEMENT AND THE IMPLEMENTATION OF STATE WILDLIFE ACTION PLANS

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State Wildlife Action Plans have been developed for each of the states in America. They focus on reversing the decline of at-risk wildlife species, recovery of listed species, maintaining the abundance and distribution of currently secure species, and conserving habitat and ecological communities. Strategies include determining species' distribution and abundance, determining habitat condition, identifying stressors, development of conservation actions, monitoring and review. All state action plans mention adaptive management, but few are explicit regarding the implementation of adaptive management. We describe how Nebraska is bringing together and engaging field biologists and researchers to address the challenge of implementing adaptive management at a meaningful, and appropriate, landscape scale.

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KEY CONTROLS ON SEDIMENT BUDGETING IN THE MISSISSIPPI RIVER FROM SOURCE TO SINK

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The Mississippi is the largest riverine system in North America and one of the most engineered rivers in the world. The mainstem river and its major tributaries are managed primarily for flood control, navigation, and water storage, and secondarily for issues such as wildlife habitat and recreation. The lower river is being increasingly recognized as a source of sediment for nourishing the degrading coastal and deltaic wetlands of the states of Louisiana and Mississippi, while sediment storage behind dams, locks and other structures further upriver is a limiting factor on water storage capacities and structure lifespans and operational capacity. This presentation is a synopsis of recent efforts by a team of investigators supported by the U.S. Army Corps of Engineers and the State of Louisiana to examine modern sediment budgets (1) below the Old River Control Structures (ORCS) that manage the Atchafalaya distributary, and (2) the reach up to the Ohio-Upper Mississippi confluence and the large dams on the Missouri River. The sediment budget and additional morphological studies upriver of the ORCS are ongoing at the time of this abstract, but the reach below ORCS is complete. Sediment budgeting of the suspended load on daily to interannual timescales provides valuable information about key processes that supply sediment to the mainstem and sequester sediment en route to the Gulf of Mexico sink.

Previous examinations of the Mississippi have focused on the historical decline in the suspended load due to the effects of dam construction and other river control and basin sediment control works. Our more recent team efforts below the Missouri dams shows that while these structures are efficient sediment traps, downstream incision (longitudinal profile adjustment) reintroduces a significant fraction of the trapped sediment. This factor, and the long transport times for sand delivery to the Gulf of Mexico, mean that it is primarily the fine sediment load only that has been impacted by human modifications for navigation and flood control. The reach downriver of ORCS has been neglected by previous studies due to a limited number of monitoring stations and the influence of tides and saline penetration. However, it is sediment supply (sand and fines) through this reach that will control its utilization for coastal restoration. Measurements of water discharge and suspended sediment load at monitoring stations and utilizing boat-based measurements were obtained for water years 2008-2012 from the reach below ORCS. The results show that both the Mississippi and Atchafalaya distributary pathways are efficient at sequestering suspended sediments, particularly the sand fraction. Loss of stream power associated with water exits upstream of the Gulf is thought to increase bed aggradation and decrease the water and suspended sediment load reaching deep water.

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APPLICATION OF QUALITY ASSURANCE CONCEPTS FROM CHEMICAL MEASUREMENTS TO ECOLOGICAL MEASUREMENTS CONDUCTED DURING ECOSYSTEM RESTORATION MONITORING

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Quality assurance (QA) approaches to minimize and document measurement variability for chemical measurements taken for environmental studies are well established. These approaches have been codified into national standards and specific guidance documents for applying these standards are widely available.

Restoration specialists sometimes assume that certain ecological measurements (e.g., visual observations by crew members of species counts, gender determinations, cover, condition, or age classes or auditory observations of species presence) are “qualitative” and therefore, not subject to evaluations of data quality. On the contrary, all measurements, including measurements taken as crew observations, have some level of uncertainty associated with them that can be evaluated for quality. In addition, many steps can be taken to control and improve the quality of these measurements.

QA concepts are applicable to all phases of a data collection effort. Concepts from standard chemical QA that are applicable to ecological QA during the planning phase include the selection of data quality indicators, conceptual models, project quality objectives, measurement quality objectives and tolerances. QA concepts applicable during the implementation phase (data collection activities) include the use of standard operating procedures, training and crew certifications, assessments and audits, calibrations, and control samples (e.g., reference plots). Data verification and data validation also are important QA tools for data review efforts that ultimately support the reporting phase of a project.

Repeated observations can be used to estimate the relative contribution of measurement error to the overall variability of the data. A goal of minimizing measurement variability to less than 10% of the total variability in the data will ensure that the measurement system is not limiting the ability of restoration specialists to detect a real change resulting from a restoration effort.
This presentation will illustrate the importance and application of typical QA/QC practices and procedures of chemical measurements to ecological measurements which often rely heavily on observations.

Focus: This presentation will illustrate the importance and application of typical QA/QC practices and procedures of chemical measurements to ecological measurements which often rely heavily on observations.

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DRIVEN INTO A CORNER: HOW THE MISSISSIPPI'S PAST WILL DEFINE ITS FUTURE

John O. Anfinson
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Arguably, the past is the greatest driver determining the Mississippi River's future. From the early 1800s to the early 1900s, three interest groups came to define the upper Mississippi's physical and ecological character today: the backers of navigation improvements, levee construction and the establishment of fish and wildlife refuges. All three interests have defined their stake in how the river is managed; all three have carved out their piece of the pie. Anyone proposing to change how the pie is divided will run up against this history. None of the key stakeholders is ready to give up its share. Equally important, the infrastructure imposed on the river by these interests and others cannot be undone easily.

There is a test looming before us. That test is about defining a sustainable future for the Mississippi River – economically and ecologically. Today, we are trying to pass the test without sacrificing anyone's claims to the river and its resources. The Environmental Management Program, for example, is trying to stave off the steady decline of the upper river's ecosystems through restoration projects, but will these projects be enough? If they aren't, what actions will America be willing to take?

This presentation provides a brief overview of the upper Mississippi River's history as a context for the issues we face today when considering how to balance the multiple demands placed upon the Great River.

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POTENTIAL ECONOMIC IMPACTS OF NATIONAL PARK UNITS AT GALVESTON BAY AND MOBILE-TENSAW DELTA

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Citizen groups in the Galveston Bay area in Texas and the Mobile-Tensaw River Delta in Alabama are exploring the potential for National Park Service designations to assist with habitat restoration, ecosystem resilience, and long-term conservation. Simultaneously, they hope that nearby communities and residents will see economic benefits from a National Park Service presence.

The proposed Lone Star Coastal National Recreation Area (Texas) would preserve critical coastal habitat and historical landmarks, protect the Upper Texas Gulf Coast from storm damage, and provide economic benefits for surrounding communities in four coastal counties. In an area where tourism is already an important economic sector, a new National Recreation Area is projected to triple visitation to participating sites in its first ten years of operation, and catalyze an 11 percent increase in jobs in the tourism industry alone. In year ten, the National Recreation Area is expected to support more than 5,200 local jobs and nearly $200 million in sales at local businesses.

Preliminary investigations in the Mobile-Tensaw River Delta (Alabama) suggest that a National Park Service designation could offer a significant and reliable economic boost, contributing to the development of a strong nature- and culture-based tourism industry surrounding the Delta. This activity would be concentrated inland, complementing an already-strong tourism industry at the beaches and in the city of Mobile.

The designation is being explored as a vehicle for long-term conservation in the Delta and associated natural areas, improving ecosystem resilience, and expanding public recreation access for hunting, fishing, boating, hiking, and wildlife watching.

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THE ECOLOGICAL BENEFITS AND POTENTIAL RISKS OF MANGROVE RESTORATION WITHIN THE TEXAS SALT MARSH-MANGROVE ECOTONE

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Wetlands are being lost at an alarming rate, particularly on the Gulf Coast of the United States. In response, coastal management commonly includes restoration projects that will augment the ecological and economic functions of coastal wetlands. Many restoration projects on the Gulf Coast focus on low elevation marsh habitat, which can substantially augment the production of some fisheries. However, these low elevation marshes, which are often dominated by a single plant species, such as smooth cordgrass (*Spartina alterniflora*), are susceptible to inundation following near-term relative sea level rise. To mitigate for this threat, restoration practitioners are increasingly including higher elevation habitat in projects, or using plant species that are more resilient to sea level rise. To that end, coastal managers in Texas have recently increased the use of black mangroves (*Avicennia germinans*) in restoration projects. Accretion rates within stands of mangroves are typically higher than in marshes, suggesting that mangroves may more readily adapt to sea level rise. This presentation will review the potential ecological benefits, remaining questions, and possible economic risks of this restoration strategy.

Currently, there is little quantitative information comparing the ecological functions of marsh and mangrove systems within the Texas marsh-mangrove ecotone, but ongoing observational and experimental studies suggest several potential benefits of mangrove restoration. Mangroves may increase shoreline stability by reducing erosion rates. In some regions, mangroves sequester carbon at higher rates than marsh grasses, though sequestration rates on the Texas coast appear to be similar among plant types. Mangroves provide a taller stature canopy that may be utilized by migratory passerines, though many shorebirds prefer marshes as foraging habitat. Other ecological benefits of mangrove restoration are not well understood, particularly in terms of consequences for fishery species. Ongoing projects seek to determine if mangroves provide suitable nursery habitat for key fishery species, and if mangroves and marshes provide similar trophic support for coastal food webs.

Additional important considerations in restoration planning include economic cost and logistical feasibility. Using restoration projects within Galveston Bay (Texas, USA) as case studies, we show that sprigs of low marsh plants such as *Spartina alterniflora* are easily harvested and transplanted, and survive across a range of elevations. *Avicennia germinans*, on the other hand, is usually best cultivated from seed, and transplantation success in the field appears to be highly dependent on environmental conditions. In particular, transplanted mangroves survive best at relatively high elevations during periods of low tides. Additional, ongoing research will help to determine the net ecological and economic benefits of mangrove restoration on the Texas coast, particularly at the northern end of the marsh-mangrove ecotone.

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CONSTRUCTION CHALLENGES IN RESTORING LOUISIANA'S BARRIER ISLANDS

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Louisiana's barrier shoreline beach, dune, and wetland habitats, have undergone substantial degradation due to oil and gas activities (e.g., pipeline construction), subsidence, sea level rise, and erosion which has led to island breaching and breakup. The barrier islands have lost their structural function, storm buffering capacity, and the protection they provide human populations, oil and gas infrastructure, inland bays, estuaries, and wetlands.

Restoration of the barrier shoreline, through mining and importing sediment into the coastal ecosystem to increase the sediment supply and strengthen the island formations, has become a high priority. Suitable borrow sources are limited in the nearshore Gulf of Mexico. Higher quality sands desirable for use in barrier island restoration efforts have been identified within the Mississippi River and in offshore deposits. These sand sources are usually a significant distance from the restoration sites. Transporting the dredged materials, either via direct-pump through dredge pipeline or hauled with hopper dredges or barges, requires significant capacity, specialized equipment, and presents many construction challenges.

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LESSONS LEARNED ON COASTAL RESTORATION PROJECTS

Kenneth Bahlinger
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The Coastal Protection and Restoration Authority (CPRA), formally Louisiana Department of Resources/Coastal Restoration Division is the state agency that is responsible for implementing coastal restoration projects in Louisiana. Since 1990 hundreds of coastal restoration projects of varying scales have been completed. As the coastal program continues to expand and restore the coast, projects continue to grow in scope, size, complexity, and impact area. Each project large and small offers a learning experience from which lessons are learned, utilized and applied to improve on future projects. Lessons learned begin from the planning and through the engineering and design, construction and monitoring phases. The CPRA continues to develop, advance and produce successful projects in the restoration of the Louisiana coast.

Project planning and development tasks include feasibility, permitting, landrights, and stake holders input. Lessons learned are to begin communication with landowners and stakeholders early in the project development. Evaluating environmental conditions and conducting pre-permit activities will ensure success later in the project process.

Engineering and design tasks include preliminary surveying, geotechnical data collection, modeling, project management, engineering, landrights, permitting, and development of plans and specifications. Most of the larger scaled projects are designed using a consultant. Lesson learned include improving coordination with the consultant, revising plans and specifications, providing thorough design survey data in the bid package, and better designs.

Construction offers the best visible aspect of lessons learned. Mandatory site visits by contractors are important and that ensure all potential bidders understand specific project site and details. During construction the parties involved include the owner (CPRA), contractor and a resident construction administrator/inspector. The resident construction administrator/inspector is usually a consultant who is on the job location at all times during construction. Other tasks and lessons learned include improving communication with all parties and the project team, developing a thorough work plan, facilitating construction meetings, surveys, change orders, permit modifications, contracting, and geotechnical information.

Post construction tasks include monitoring, a final project completion report, and a lessons learned meeting with the team. After the project is completed team input is important to discuss the successes and challenges of the project. The team will develop a list of concerns and recommendations that can be applied on future projects. The end result is a better more efficient, successful, project.

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ANALYSIS OF COST-EFFECTIVE RESTORATION: PRINCIPLES AND TOOLS FOR REDUCING UNCERTAINTY IN DESIGN

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Predicting "existing" erosion rates and the effectiveness of mitigation strategies can be readily conducted with measurements of boundary resistance and physically-based modeling tools. The approach is neither difficult nor time consuming, and provides for reductions in risk and uncertainty in design because analyses provide quantifiable threshold values for the range of hydrologic conditions over user-specified time scales. Placed in the broader geomorphic context of system-wide stability conditions, application of metrics such as excess shear stress and the channel-stability index can be used to determine appropriate strategies for erosion control, stormwater management and stream restoration.

Examples covering a range of objectives, locations, and spatial and temporal scales are presented including: (1) determining threats to park infrastructure along a single, migrating meander bend, Sandy River, OR; (2) migration of meanders and selection of a gas-pipeline route, Bayou Pierre, MS; and (3) cost-effective management strategies for reducing streambank loadings to the Great Barrier Reef, Burnett River, AUS.

At Oxbow Park on the Sandy River, daily time-steps from an 8-year period bounded by bank surveys were used to calibrate the Bank-Stability and Toe-Erosion Model (BSTEM-Dynamic). To provide management options for protecting park infrastructure over the next 50 years, 50-year simulations predicted the position of the migrating bend at 10-year increments. Further simulations of potential mitigation strategies provided a range of management options based on reductions in total retreat and relative costs. Using 2-D hydraulic data which provided near bank stresses at 9 "spokes" along three meanders of Bayou Pierre, MS, BSTEM simulations were similarly used to predict meander migration and risks to existing and proposed pipeline routes.

Bundaberg, Australia was the site of devastating floods in 2011 and 2013. Bank retreat (typically 20-60m) resulting in the loss of agricultural land and delivery of high sediment discharges to the Coral Sea are management concerns. To reduce erosion with limited financial resources, cost-effective mitigation approaches were determined based on BSTEM predictions of bank erosion under "existing" and a range of parameterized mitigation strategies. These included combinations of vegetative plantings, bank-toe protection, bank-slope reduction and placement of bendway weirs and compared to unit cost per amount of "land saved." Results demonstrate that not all strategies are effective is all settings (alluvial vs. estuary) and that the overall strategy must be placed in the context of trends in system instability caused by series of dams and weirs.

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NON ROCK ALTERNATIVE TO SHORELINE PROTECTION DEMONSTRATION PROJECT

***Jamie Bartel*[1]*, Scott Bartkowski*[2]*, Tom Brown*[2] *and Tim Hillier*[3]**

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Three distinct areas of Louisiana shoreline were selected by NRCS for design of non rock alternatives for shoreline protection; the project sites included: (1) Shark Island in Iberia Parish, (2) Lake Salvador in Jefferson Parish, and (3) Bayou Perot in Lafourche Parish. Each of the shoreline sites are unique in that other means of shoreline protection have not fully reached their potenitial and are questionable in terms of their limitations, or no solutions were offered given the unique field conditions. This project is to demonstrate the effectiveness of treatment for shoreline protection—a design that can withstand settement limitations, weather storm surge, and ultimatley protect the shorelines from further erosion. CDM Smith and Living Shoreline Solutions, Inc. (LSSI) developed a shoreline restoration solution for each of these sites using an innovative technology. The technology used was Wave Attenuation Devices (WADs ®) developed exclusively by LSSI (U.S. Patent 6,186,702B1). The WADs ® are a unique design developed to both reduce shoreline erosion and produce habitat in the most general terms and the design is flexible for various coastal situations.

The project involved analysis and design of shoreline protection along 500 linear feet of shoreline at each of the sites. In support of design efforts, site visits were conducted at each of the sites to verify field conditions and to check the accuracy of the bathymetric surveys. The design process began with geotechnical analysis to determine settlement over a three-year test period and to show that the WAD® would maintian an elevation of 1-2 feet above mean high water post construction. The most significant design challenge using the WAD® system was settlement of the structures in very soft, peaty offshore substrate along the shorelines. Wave and water level analysis along with structural analysis was completed to demonstrate that the WAD® could withstand the calculated wave forces without overturning. An iterative design approach was used in developing the final WAD® unit design and WAD® system configuration, based on geotechnical analyses that determined maximum load bearing capacity, and minimum settlement. The final design package was completed within 75 days as required by NRCS.

Each unit was designed to be 7-feet in height with a 10-foot base, and each unit will include a sacrificial concrete base (2.5 feet in height) to account for settlement, and to maintain the ability to mitigate shoreline erosion by dissipating 90% of the regional wave energy. The array of WAD® along each stretch of shoreline consists of 182 units placed side by side, base to base, giving the units increased stability and providing WAD® array integrity. It is expected that after mobilization and manufacturing of the WADs®, each array can be installed within 7 days using a crane-mounted barge, and all three sites would be complete within 4 months. The construction phase for the Shark Island site began in December 2013.

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

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Migrating the leading edge of a species distribution in advance of climate change effects could be useful where dispersal is limited and rate of climate change is predicted to increase beyond the capacity of species to keep pace. Species occupying the seaward end of coastal gradients may be capable of establishing landward with the removal of biological filters. In August 2011, I initiated a reciprocal transplant experiment in which a series of 4 m^2 plots (n=135) was established spanning coastal assemblages across the East River estuary in northwestern Florida. Vegetation was removed (treatment) or left undisturbed (control). Individuals of the dominant graminoids representing the gradient from salt marsh to upland pine savanna assemblages (*Spartina alterniflora*, *Juncus roemerianus*, *Cladium mariscus*, and *Aristida stricta*) were harvested. Each plot was subdivided into four $1m^2$ subplots, which were randomly assigned to a species. Ten individuals of the assigned species were planted into each of the subplots. All species successfully established in plots located in their source assemblages. In seaward plots, the upland grass *A. stricta* was the only species that did not survive, and the fresh marsh dominant *C. mariscus* had low survival, suggesting that abiotic stress limited these intolerant species. In all other parts of the gradient, the four species successfully established and were surviving. The most dramatic colonization result was that of *J. roemerianus*, the brackish marsh dominant, which survived in all freshwater wetland and upland habitats and appeared quite healthy. There were no differences between control vs. treatment plots, but in some cases initial survival was enhanced in control plots, possibly due to protection from herbivory. These results suggest that assisted colonization of downslope species into assemblages farther inland and upslope of their original source populations is feasible.

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TESTING THE ABILITY OF BIOFOUL FOR THE PURPOSES OF ENHANCED REMEDIATION OF ACID MINE DRAINAGE

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Acid mine drainage (AMD) is an important environmental concern due to the low pH waters, and high metal concentrations that are produced. There are many issues associated with AMD including habitat loss, depletion of biodiversity and increased erosion and sedimentation.

This study is focused on the enhanced remediation of AMD through the addition of biofoul, an agglomeration of mussels and seaweed. Biofoul is previously untested for the purposes of AMD remediation, but we believe there is potential due to the abundance of both organic and inorganic carbon. The two sites used in this study are the former Consolidated mine and the former Gullbridge mine, both near Baie Verte, Newfoundland. In conjunction with previous work, data obtained through in situ field measurements and laboratory analyses of samples collected at the two sites indicate that these sites are actively leaching AMD into downstream water bodies. Water and sediment samples were obtained from each site for use in a variety of adsorption and dissolution bench-top batch experiments.

Results from the bench-top batch dissolution experiments showed that biofoul has a strong neutralizing capacity. However, the aqueous copper concentrations were higher in the experimental treatments where biofoul was added. The source of the copper is most likely from the biofoul. This is because the biofoul samples we obtained accumulate on aquaculture nets, which are coated in copper sulphate paint that acts as a retardant for the accumulation of mussels and barnacles. A further experiment examined the combined effect of biofoul and dolomitic lime. Results from this treatment showed that relative to the biofoul only treatment, the neutralizing capacity of the mixture increased and copper levels decreased, but to levels that were still up to 30 times higher than the maximum allowable concentration for mine effluent. Adsorption batch experiments were performed to determine the potential affect biofoul would have if it were mixed with natural sediments for the construction of a permeable reactive barrier. Background sediments from each mine site varied in their ability to neutralize pH, and both were able to substantially reduce copper concentrations. The addition of biofoul increased the neutralizing capacity of the both sediments.

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RESTORING THE NATURAL WATERSHED DIVIDE OF THE CHICAGO RIVER

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What do advances in wastewater treatment and innovations in stormwater treatment, invasive species management, Panama Canal expansion, new barge technologies, and rail logistics all have to do with restoring the natural divide of the Chicago River? Everything! The Great Lakes Commission and its partners have a vision to restore the natural watershed divide of the Chicago River. In doing so, they hope to stop or slow down the cross-watershed spread of invasive species and to protect the ecosystems of both the Mississippi River and Great Lakes Watersheds.

To put forth a coherent vision for this important effort, the partners need to tackle the system's basic operational framework and its ecosystem functions. This presentation will address the multipronged approach used to establish a vision and a plan for restoring the natural divide.

The Chicago Area Waterway System (CAWS) features approximately 130 miles of natural and constructed rivers, canals, locks, and other structures in Chicago and northwestern Indiana. The Great Lakes Commission and its partners have embarked on a project to develop and evaluate alternatives for physically separating the Mississippi River and Great Lakes basins in the CAWS to prevent the movement of Asian carp and other aquatic invasive species. Analyses thus far show that separation can be achieved while maintaining or enhancing water quality, flood management, and transportation. The engineering and economic analyses also suggest that separation is feasible and can provide a solid foundation for long-term solutions to the threat of aquatic invasive species.

Separation is needed to prevent the movement of Asian carp and other invasive species between the Mississippi River and Great Lakes basins in the Chicago-area waterways. Asian carp, in particular, are an imminent threat. Recent research confirms that they can survive and spread in the Great Lakes, and that the CAWS is the most likely point of entry. The U.S. Army Corps of Engineers has identified 39 aquatic invasive species with a high risk of passing into either the Great Lakes or Mississippi River. More than 250 nonnative species are already established in one or both of the basins, and invasive species cost the Great Lakes region alone an estimated $200 million annually. For these reasons, separation appears to be the best long-term option to prevent Asian carp and other aquatic invasive species from invading the Great Lakes or Mississippi River basins through Chicago-area waterways.

Like most major infrastructure projects, the costs of separation are substantial. However, separation could generate significant benefits for the Chicago region and the Great Lakes and Mississippi River basins as a whole, with economic analyses showing the potential for between $1.4 billion and $9.5 billion in long-term savings.

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MODELING SPATIO-TEMPORAL RESPONSES OF WADING BIRD INDICATOR SPECIES ACROSS RESOURCE GRADIENTS FOR WETLAND RESTORATION

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Species distribution models (SDM) link species occurrence with a suite of environmental predictors and provide an estimate of habitat quality when the variable set captures the biological requirements of the species. SDMs are inherently more complex when they include components of a species' ecology such as conspecific attraction and behavioral flexibility to exploit dynamic spatio-temporal resources. Wading birds are highly mobile, demonstrate flexible habitat selection, and respond quickly to changes in habitat quality; thus serving as important indicator species for the Everglades.

We developed a spatio-temporal, multi-SDM framework using Great Egret (*Ardea alba*), White Ibis (*Eudocimus albus*), and Wood Stork (*Mycteria americana*) distributions over a decadal gradient of environmental conditions to predict species-specific abundance over space and spatial occurrence over time. Models jointly accounted for flexible habitat selection of resources within and among temporal scales, responses to environmental gradients, conspecific attraction, and spatial autocorrelation. In temporal models, species demonstrated conditional preferences to resources and a marked response at multiple temporal scales, requiring long-term wetland inundation as a prerequisite for large foraging aggregations in shallow depths. Similar responses were observed in models predicting spatial occurrence over time, while accounting for spatial autocorrelation. Species clustered in response to differing habitat conditions, indicating that social attraction can co-vary with foraging strategy, water-level changes, and habitat quality.

This modeling framework was applied to evaluate the multi-annual resource pulses of climate change scenarios and restorative hydrological regimes by tracking changing seasonal and annual high quality foraging patches and their abundance in the landscape.

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WORDS MATTER: USING COMMUNICATIONS TO IMPROVE RESTORATION EFFORTS

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Restoring our natural areas requires people to make specific changes in their behavior. Just educating people on a topic by itself will not inspire most people to take an action. Instead, we must use communication techniques to reach target audiences with specific values-based messages. Environmental educators and conservation staff must understand and consider the needs and values of their audiences in order to create compelling and motivational materials and websites. Values-based communications and social marketing tools can help move people toward making behavior changes that encourage restoration.

Values-based communication and social marketing are strategies that create social change by building personal connections to an issue, the foundation of how marketing firms sell products from cars to beer. Environmental organizations, restoration managers and advocates can adopt this principle to "sell" audiences on important behavior changes like landscaping with native plants or volunteering at work days.

Values-based communications draws on the values or beliefs that a person already has to inspire both attitude and behavior change. Social marketing is a strategy, popularized by Doug McKenzie-Mohr, that offers a step-by-step process to inspire behavior change through public communications. Combined in a communications strategy, these theories can move audiences toward sustainable decision-making. The goal of a communications strategy is to motivate a target audience to take some action or change their behavior. The process of developing a communications strategy incorporates values-based language, social marketing tools and measurable outcomes to form an implementable plan.

Bluestem Communications has created tools and an easily replicable process for communicators to integrate into their standard planning systems. These tools and processes help them create innovative and targeted environmental outreach campaigns for a variety of audiences—from volunteers to city councils. The act of incorporating communication strategies into planning efforts can make or break efforts to change behaviors and promote sustainable decision-making.

In order for people to make real, lasting behavior changes, we must appeal to their values and beliefs and remove the barriers that might prevent them from making a change. Communicators must understand and consider the needs and values of their audiences in order to create compelling and motivational materials. Simple communications tools can help communicators understand those values.

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SEAGRASS RESTORATION AND ECOSYSTEM SERVICES: CHALLENGES OF MEASURING THE NECESSARY ECOSYSTEM FUNCTIONS

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There is an increasing interest in ascribing economic value to ecosystem services across a broad array of habitats. Ecosystem function is thought to serve as a basis for delivery of many ecosystem services. Accordingly, restoration of habitats could be considered as a process by which ecosystem function is re-established, leading to the potential provision of ecosystem services. Bullock et al. (2011) pointed out that this thinking is somewhat new to the objectives of restoration. Here I discuss the challenges of adopting such an approach in the field of seagrass restoration.

Much evaluation of seagrass restoration to date has focused upon the sustained establishment of seagrass cover. Numerous examples of establishing new seagrass beds are available but questions still remain about wide-scale restoration as a management strategy (Thom et al. 2012). An extended view of seagrass persistence after planting in both temperate and tropical settings beyond 2-3 years is not commonly available.

To date, we have a poor understanding of how long term dynamics of a planted seagrass taxon should be linked to ecosystem function in a restored system. There is general agreement that ecosystem function, such as support of biodiversity and sediment retention, should increase in vegetated compared to unvegetated areas, but the nature of this relationship (shape of the curve) may be influenced by a number of factors, complicating any prediction of ecosystem function based simply upon plant structural metrics. Bell et al. (1995) showed that algal trapping of identical arrangements of seagrass varied depending on the spatial scale of measurement. Such results suggest that organisms respond to structure differently depending upon the location of structure within a landscape, or movement/dispersal of organisms varies with perimeter to core ratios of habitat patches or edge effects. Meyers (2010) demonstrated that ecosystem function, measured as the accumulation of particles and organic matter, did not maintain a consistent relationship to seagrass shoot density when examined in high versus low hydrodynamic regimes. Recently, studies on juvenile blue crab recruitment revealed that densities of juvenile crabs were 5.6X higher along a western versus eastern shoreline although seagrass cover values were equivalent (Ralph et al. 2013). Combined these examples suggest that ecosystem function may vary for measures of similar seagrass structure depending upon location, hydrodynamic regime, and/or spatial scale of measurement; all must be considered in study design. Furthermore, if an ecosystem services approach is to be developed for seagrass restoration efforts, monitoring of seagrass structure and associated ecosystem functions for 2-3 years post- planting may no longer be sufficient.

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AN OVERVIEW OF 40 YEARS OF PROTECTION AND RESTORATION ON THE MISSISSIPPI RIVER MAINSTEM

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Beginning almost 200 years ago, North America's largest river has been dynamically altered for commercial navigation, flood management, water use and energy. From Minneapolis, Minnesota to St. Louis, Missouri the river is impounded and leveed for navigation, flood management and to a lesser extent hydropower. South of St. Louis to the Gulf of Mexico the river is confined by levees and channel training structures to 3 million acres or an eighth of the original 24 million acre alluvial valley, to minimize flooding and provide year-round navigation. These system changes are further aggravated by urban and rural inputs that include excess nutrients, sediment, contaminants, and thermal pollution.

The amazing resilience of the Mississippi River is not lost on river ecologists so over the last forty years they have worked to pursue ways to protect and recover important river function, process and structure within the confines of an altered river system. Reinforced by the Clean Water Act (CWA) and the National Environmental Policy Act (NEPA), legal action in 1973 and 1974, forced initial action to minimize environmental impacts from navigation dredging and disposal on the Upper Mississippi River (UMR). That work conserved almost a thousand acres of wetlands from dredge material disposal and the partnership went on to focus on resolving other river restoration issues. A Master Plan was developed for the entire UMR which later provided the backbone for what would become the 27 year old Environmental Management Program, providing the funds to restore over 100,000 acres of riverine floodplain habitat and support a robust monitoring program. Not resting on their achievements, the partners have collaborated on demonstrations to re-operate the dams to provide more optimum water levels (reduced) during the growing season in navigation pools to promote aquatic plant regeneration.

Throughout the river mainstem but especially in the lower 1200 miles of the river, natural resource agencies and the Corps of Engineers have removed, notched and shortened over 525 channel training structures to improve main channel and off channel connectivity. The St. Louis District of the Corps of Engineers has engineered innovative channel structures that maintain the navigation channel and at the same time diversify aquatic habitat for fish and other aquatic organisms. Multiple rounds points, "W" wingdams, chevrons, groynes (groins), offshore revetment and hard points now offer alternatives to classic wingdike fields, revetment, and closing structures for the entire river mainstem. To address Endangered Species Act issues the Corps of Engineers and U.S. Fish and Wildlife Service through targeted efforts have now reconnected 52 miles of side channels at low to moderate flows to improve off channel habitat for the pallid sturgeon and interior least tern. The end goal could reach about 300 miles of reconnected side channels.

All of the ecosystem protection and restoration actions described above were done with little or no impact to commercial navigation and flood management. The success of these demonstrations must be scaled up to the entire system and become the routine manner to manage the river to balance the multiple demands on the Mississippi River.

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A LARGE-SCALE NORTHEASTERN ECOSYSTEM RESTORATION PROJECT: SEEING THE DESIGN THROUGH CONSTRUCTION

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The Brookland Mitigation Site, located in Middlesex County, New Jersey, was selected for the compensatory mitigation of wetland impacts resulting from the construction of the New Jersey Turnpike Interchange 6-9 Widening Program. The site encompasses 412 acres of predominately agricultural and forested land that drains to the Millstone River, Cranbury Brook, and their anthropogenic tributaries via surface water runoff and groundwater flow. The site is almost entirely situated within the 100-year floodplain of the existing waterways, which are all regulated under the NJDEP Agency regulations.

The design goal was to establish a variety of ecosystem habitats, including vernal pool complexes, forested freshwater wetlands, and reforested upland areas. The locations of these habitats were dictated by the site's existing features including modified agricultural wetlands, tile drains, regulated floodways, cultural resource areas, site topography, and observed groundwater levels. The overall site design was also governed by the required mitigation credits and the need to keep all excavated materials onsite.

The site-specific wetland characteristics were translated into quantitative water budget models to predict long-term behavior. A hydraulic and hydrologic analysis of the site was developed to assess the hydrologic response of the proposed design and its impact on the floodplain and flood storage characteristics. The complexity of the site required fourteen interconnected wetland water budget models to be integrated into a model network to capture the hydrodynamic interactions and simulate daily fluctuations in surface water and groundwater within the site. Special methodology was developed to bridge data gaps in hydrologic and climatic data. Daily fluctuations in water level at the site were simulated to help ensure the sustainability of a hydrologic regime capable of supporting the targeted wetland and upland habitats and species.

Based the water budget simulations, habitats were established by lowering ground surface elevations within the proposed wetland and vernal pool areas, raising ground surface elevations in existing upland areas, and raising the thalweg of the anthropogenic tributaries to reconnect them to their floodplains, thus restoring a more natural hydrologic and hydraulic regime to the site.

Site construction commenced in October of 2012 and was completed in September of 2013. The site is currently being monitored to meet regulatory requirements. This presentation will be a continuation of a presentation on the project's conceptual and final design given at NCER 2013, focusing on the construction process, lessons learned, and adaptive management measures implemented during construction.

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ECOLOGICAL RESTORATION OF BRIDGESTONE'S NEW BEGINNINGS WOODLAWN WILDLIFE AREA AND WARREN COUNTY MANUFACTURING PLANT

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Ecological enhancements considered at the inception of planning for environmental remediation at Superfund, RCRA and brownfield sites can be a cost-effective and efficient way to increase, create and/or improve wildlife habitat. Ecological remedial plans can contribute greatly to protection of human health and preserve the integrity of surrounding communities while further enhancing the environment for wildlife habitat and resource management. An ecological enhancement modifies a site to increase/improve habitat for plants and animals while protecting human health and the environment. An ecological enhancement can include natural remediation technologies and/or represent an end use, which restores/increases the ecological value of the land and can benefit multiple stakeholders, such as regulatory agencies, the regulated community, local communities and the general public.

The Wildlife Habitat Council works with its members and partners to address enhancing and monitoring wildlife habitat on private lands, including contaminated properties. Site-specific considerations and an evaluation of goals and objectives, regulatory constraints, potential technologies, probable costs and likely benefits need to be objectively studied at each potential site.

Bridgestone's New Beginnings Woodlawn Wildlife Area will be discussed as it was once a working landfill turned superfund site that today hosts thousands of species of plants and animal and serves as an outdoor conservation education learning center for citizens of many ages in Port Deposit, MD. The site remains active in creating and maintaining wildlife habitat on a closed landfill and adjoining property that is part of a community approved remedial plan that saved millions of dollars.

Mr. Bent will also describe Bridgestone America's ecological and habitat restoration projects on non-remedial lands such as Bridgestone Americas, Inc.'s Warren Plant BEECH, Tennessee**.** The Warren Plant Bridgestone Environmental Education Classroom and Habitat (BEECH) Program is designed to increase biodiversity on nearly 700 acres of the property by implementing and linking habitat enhancement projects for a stable, more diverse ecosystem, and by educating and involving plant employees and community volunteers in wildlife conservation and environmental education.

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AN INNOVATIVE APPROACH TO 'RESTORATION' OF GAS CANALS

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Based on an understanding of the impacts associated with gas canals, the prevalence of these features, and the economic challenges associated with mitigating the impacts of these canals, we have developed a cost effective innovation for filling gas canals. The approach we are advocating involves the removal of spoil banks along a reach of canal necessary to produce sufficient fill material to create a more complete plug or weir across the canal at a fraction of the cost necessary to gain the same restoration benefits as complete canal filling but with greater resource benefits than comparably priced fractional fill of the canal. This approach provides a more cost effective solution than complete canal filling, delivers and allows design flexibility to facilitate the retention of other canal functions (e.g., small boat navigation, aquaculture production, etc.).

This approach has been used nationwide at smaller scales to restore hydrology in formerly ditched and drained tidal wetlands, stream restoration, ditched agricultural wetlands, etc.. The principle is valid though the scale for interrupting gas canals is larger. We developed this approach while partially filling approximately 4 miles of canals in Jean Lafitte NHP for the NPS. Since this approach will allow the construction of multiple weirs using a small fraction of the material needed to completely fill canals, greater lengths of canal can be modified to more effectively reverse the hydrologic (and other) damages wrought by these canals.

The placement of fill materials into canals is a proven technique to incrementally improve wetland hydrologic conditions, including improvements to wetland hydrology, reestablishing native wetland vegetation, improved aquatic biota habitat, reducing marsh surface subsidence, etc. The degree of improvement is expected to be a function of the amount and nature of the material used and the extent to which the canal's cross sectional volume is filled.

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PUBLIC-PRIVATE CONSERVATION IN LOUISIANA: NATURAL RESOURCES CONSERVATION SERVICE AND THE NATURE CONSERVANCY

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The Nature Conservancy (TNC) has been working collaboratively with the Natural Resources Conservation Service (NRCS) in Louisiana over the past 25 years. However, in 2010 a significant escalation in our partnership was catalyzed by 2 separate but related events. First, TNC launched the "Longleaf Pine Integrated Landscape" initiative. This is a construct of TNC to describe the multi-state effort to coordinate TNC's work in longleaf pine systems. "Platform sites" within the Integrated Landscape provide opportunities to focus conservation action, coordinate with partners, and leverage and export strategies. At about the same time NRCS signed an MOU with the U.S. Department of Interior and the Department of Defense. The goal of the MOU was to establish a framework for cooperation among those departments, along with state and private partners, to achieve the goals of the America's Longleaf Restoration Initiative as described in the Range-Wide Conservation Plan for Longleaf Pine. This commitment has resulted in significant longleaf restoration accomplishments through regional American Recovery and Reinvestment Act (ARRA) projects and the USDA - NRCS wildlife habitat incentive program (WHIP). The MOU also commits the agencies to better collaboration with non-federal partners through the Declaration of Partnership (DOP) which includes 30 signatories to date.

In 2011, TNC, NRCS, DOD and other partners developed a proposal to hire a South Central Louisiana Plains Conservation Coordinator that would implement objectives as defined for the 2 Significant Geographic Areas (Fort Polk and Kisatchie National Forest) designated for the state. This effort was integrated with the Texas-Louisiana Longleaf Strategic Plan to support the goal of reestablishing 8 million acres of longleaf pine throughout its range (from a present estimate of 3.4 million acres). This effort continues at this time and represents a large-scale, integrated conservation delivery network with a highly value added public-private partnership between the NRCS and TNC as well as other partners.

Present efforts to replicate this model are ongoing in relation to the Lower Mississippi Alluvial Valley, ecosystem services, as well as freshwater habitats throughout the state. Collaborative approaches to developing tools for decision making with subsequent linkage to directed and strategic landowner incentives will be vital to afforestation, carbon sequestration, and water quantity/quality improvement for Louisiana into the future.

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CONTRASTING ROLES IN COLLABORATIVE ADAPTIVE MANAGEMENT: A POTENTIAL KEY TO PROGRESS

Jim Berkley
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The Missouri River Recovery Program is a Collaborative Adaptive Management (CAM) program like many others in the U.S. that includes collaboration among a stakeholder group, an independent science advisory panel (ISAP) and a federal agency responsible for decision making. The Missouri River Recovery Program consists of a 70 member stakeholder group, 6 member ISAP and the U.S. Army Corps of Engineers as the decision making agency. This presentation explores the decision-making tension among the three groups that arises from their unique roles, responsibilities and interests in the Missouri River CAM context. Adaptive management presents challenges to all three groups; the agency's need for a deliberate pace to progress that provides legal certainty when making management changes, stakeholders'need for quick response to scientific information that suggests a needed management change while still maintaining certainty about protecting vested interests and, an ISAP that provides independent scientific advice that is trusted yet geared toward providing independent, credible, scientific information and advice that is not focused on considering stakeholder and agency interests. The tension not only acts as a restraint to rapid progress but also can act as a force which moves progress at a greater rate than might occur without the tension among the three. The presentation explains how the distinct roles among the three provide a general framework for progress.

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SCI-TEK: A METHOD FOR EFFECTIVE INTEGRATION OF TRADITIONAL ECOLOGICAL KNOWLEDGE INTO COASTAL RESTORATION DECISION-MAKING

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Making more informed coastal restoration and hazard mitigation decisions has become increasingly important given limited resources available for restoration and hazard mitigation projects, and the increasing magnitude of marsh degradation and loss across the Gulf of Mexico coast. An interdisciplinary team of physical and social scientists, State and Federal agency coastal managers, and fishers/resource harvesters of affected coastal communities collaborated on related studies with the goal of aiding restoration and hazard mitigation decision making by engaging local ecosystem knowledge holders in the process. Together they investigated the feasibility and benefits of integrating the traditional ecological knowledge (TEK) of coastal populations with geospatial technology and scientific datasets to assess how the integrated knowledge that results might inform project planning for coastal restoration and hazard mitigation.

Through these collaborative efforts, a more comprehensive and transferrable method of assessing localized stakeholder priorities and translating that information into a format compatible with existing coastal hazard mitigation and restoration decision-support tools was developed. The process developed involves recording TEK in a natural, egalitarian setting which is then converted into Geographic Information Systems (GIS) models that can facilitate incorporation into the existing restoration planning process. This is achieved by using Remote Sensing (RS), science-based datasets, and GIS to produce mapping products that represent the local fishers' and harvesters' TEK.

The collaborative team developed a method for effective stakeholder engagement and a process for producing coastal restoration and hazard mitigation mapping products from information derived and prioritized with TEK. The current model of engagement via public meetings can generate extensive transcripts of public opinion, but it is limited in terms of scope and stakeholder representation. It is also difficult to incorporate into the scientific toolbox used to make decisions about restoration. By mapping TEK we translated this knowledge into a usable dataset layer that incorporates quality control, and can be confidently used in combination with existing datasets. Moreover, the researchers used the stakeholder engagement process to help address the general lack of understanding by physical scientists and managers/decision-makers of the value that TEK offers and to illustrate how TEK helps to bridge the communication gap that typically exists between scientists and traditional knowledge holders.

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IMPLEMENTATION OF ADAPTIVE MANAGEMENT STRATEGIES FOR BIO-ENGINEERED SHORELINE STABILIZATION IN GREAT EGG HARBOR BAY

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The New Jersey Department of Transportation (NJDOT) Route 52 Causeway Replacement Project is one of the largest transportation infrastructure projects undertaken by the NJDOT. The causeway crosses Great Egg Harbor Bay connecting the coastal communities of Ocean City and Somers Point and serves as the principal coastal evacuation route. The project consists of replacing the 2.2 mile causeway, including 4 bridges as well as reconstructing the approach roadways. The Great Egg Harbor Bay is a shallow, tidally controlled bay composed of large expanses of open water and salt marsh islands. The bay is valued for its shellfish resources, wetlands, wildlife habitat, and recreational and commercial fisheries. During the environmental regulatory review process, federal and state resource agencies expressed concern that construction of the new causeway may increase erosion of the already severely eroded shorelines of the salt marsh islands. The NJDOT through the Federal Highway Administration committed to deterring erosion and restoring a more stable shoreline by employing bioengineered solutions.

Four bioengineered stabilization details were developed and implemented to restore the shoreline and control erosion. The details were tailored to the local energy regime and generally consisted of grading the shoreline into the existing marsh with a 3:1 slope using available on-site material and a combination of hard armoring and wetland plantings. A coir fascine (coconut fiber log) was anchored at approximately mid tide elevation (El. 0' NAVD 88) with *Spartina alterniflora* planted landward of the coir fascine with soil stabilization matting and in most areas riprap was placed waterward of the coir fascine. The contract intentionally divided the shoreline stabilization activities over two years in order to apply lessons learned and best practices from the first installation to the second. The first installation was completed over the summer of 2010 with mixed results attributed to a combination of concerns over the quality of installation work, challenging environmental conditions, and material quality. Areas with low energy regimes or with sandy substrate were generally successful. Others required design changes to correct for problems with the installation or unique site conditions.

Design changes included changing planting materials from pre-vegetated coir mattresses to individual plugs, increasing riprap size, installing the coir fascine at a higher elevation, herbivory control, and most importantly, sharpening installation techniques to prevent soil loss. Grading for the second season of shoreline stabilization was performed in August 2011 and February 2012 with planting in spring 2012. Following construction, the design and construction were tested by Hurricane Sandy in October 2012 and experienced minimal impact. Monitoring results are indicating that where employed, adaptive management strategies have performed as designed and are effectively mitigating erosion of the restored marsh island shoreline.

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COASTAL REHABILITATION THROUGH SUSTAINABLE MANAGEMENT OF MANGROVE COMMUNITIES IN KUWAIT

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Kuwait Institute for Scientific Research (KISR) initiated studies in 1993 to establish biological feasibility for introducing mangroves by evaluating different ecotypes of *Avicennia marina, Avicennia germinans* and *Ceriops tagal* and establishing five plantations of *Avicennia marina* along Kuwait Bay. Assessment of the likely impact of mangrove introduction on the coastal environment and marine biodiversity was conducted to demonstrate its influence on coastal ecosystems. Research efforts are presently continued to establish indicators to measure the success and develop/ refine techniques for sustainable management of mangrove ecosystems under harsh environmental conditions of Kuwait. The presentation will discuss KISR experience in managing the mangrove ecosystem.

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AN OVER VIEW OF GOODS AND SERVICES OF THE ARID ECOSYSTEM IN NORTH WESTERN COASTAL REGION, EGYPT

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The present study includes the general description of the geography, soil characteristics, present land use, potential land resources and water resources of the study area. It also contains information related to socioeconomic assessment and livelihood of the local inhabitants. It also comprises a concise description, economic uses and ecological importance of plant species in the study area. Considerable records, observations, information and material were collected through 50 field trips along the north western coastal region from Burg El-Arab to Sallum. Eleven habitats have been distinguished and 82 sites were distributed in different habitats.

A total of 279 species were recorded during the surveys of the selected stands in the study area , of which 163 are perennials and 116 are annuals. One hundred and fifty five species are evaluated as medicinal plants. Medicinal herbs in the northern western coast are a source for income and one of the major economic activities that defines some of the local community members. An evaluation of the species constancy in relation to habitat types was indicated.

The services offered by the ecosystems of the study area can be divided into two main categories: a- the environmental services that include, biodiversity conservation ,in terms of habitat and species diversity. The habitats support diverse flora and fauna (approx. 250 flowering plants, 300 invertebrates, 200 avifauna, 30 herpetofauna and 28 mammals). Some of these biota are endemic and/or threatened and b- the economic services which include: 1-Grazing, where domestic and wild animals can graze and browse 94 of the species growing in this region ,2-Fuel,3- Human food (33 species in this region are eaten by local inhabitants).4-Traditional uses and 4-Some other services of minor representation and characterized by the complete or partial loss of natural vegetation such as rainfed agriculture (9 %), military uses (6 %), quarries and fragmentary uses (2.6 %). Thousands of local tourists already visit the area annually for recreational purposes (3.4%)

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EVALUATING THE INFLUENCE OF DISTURBANCE ON MACROINVERTEBRATE COLONIZATION AND DECOMPOSITION OF LEAF PACKS IN UPPPER COASTAL PLAIN HEADWATER STREAMS

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Fresh water is a vital resource for many biota, yet these ecosystems suffer high rates of anthropogenic disturbance. Offsetting stream disturbance through restoration is a common but expensive practice. An improved understanding of both functional and structural characteristics of disturbed stream systems aims to increase resource use efficacy. This study examined variation in macroinvertebrate colonization of leaf packs in reference and disturbed Upper Coastal Plain headwater streams. Using Principal Component Analysis, relationships were established between disturbance type and the richness, diversity, invertebrate density per gram of remaining detritus, and relative abundance of several important groups of macroinvertebrates. Analysis of variance on three of the seven components distinguished reference sites from one or more disturbance categories ($p < 0.05$). A fourth component appeared to make the distinction in one year, but not the other. No differences in leaf decay rate among disturbance types were found. Shredder and Trichoptera richness were important in distinguishing runoff from reference sites. Similarly relative abundance and density of shredders and Trichoptera also aided differentiation of reference from runoff sites. Combining collector-gather relative abundance and density with Tricoptera and Ephemeroptera density further set references apart from runoff sites. Streams influenced by excessive run-off exhibited the most divergent macroinvertebrate colonization patterns compared to reference sites. Similarity in decomposition rates was surprising given large differences in shredder abundance across disturbance categories. This suggests that either the examined disturbance categories did not influence decomposition, or that abiotic drivers of decomposition may mask lower shredder presence in disturbed streams. Findings also suggest that certain combinations of macroinvertebrate measures can be utilized to distinguish both reference and disturbance categories (especially run-off) in Upper Coastal Plain streams. These findings could aid decision making on the determination of whether a stream is a candidate for restoration.

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INNOVATIVE WATER SOLUTIONS AND RESTORATION USING THE ENVISION™ SUSTAINABLE INFRASTRUCTURE RATING SYSTEM

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The award-winning sport fish hatchery in Alaska uses innovative water management techniques to recycle 95 percent of water, control stormwater, and use energy efficiently. It's a "signature infrastructure" project according to designers.

The Institute of Sustainable Infrastructure (ISI) announced in July that the first completed project assessed using ISI's new Envision™ sustainable infrastructure rating system is the William Jack Hernandez Sport Fish Hatchery in Anchorage, Alaska. The 141,000-square-foot hatchery facility is the largest indoor sport fish hatchery in North America, and contains many sustainable features, including sophisticated recirculation technology that reduces by 95 percent the water and energy normally used by conventional hatcheries, saving money and limiting withdrawal of groundwater from the aquifer. The hatchery's Gold-level Envision™ award represents significant achievements in sustainable infrastructure design. The project was assessed using the 60 Envision™ sustainability criteria in the categories of Quality of Life, Leadership, Resource Allocation, Natural World, and Climate and Risk.

The Hatchery raises 6 million fish a year, including Chinook and Coho salmon, rainbow trout, Arctic char and Arctic grayling. The facility's 107 tanks and 35 mini hatcheries are connected by a network of over 8.5 miles of piping, conduit and duct work. Three different water systems are in place at the hatchery, in order to accommodate the progressive growth cycles of the fish as they develop from fry to adult size: Stage 1: single-pass approach; Stage 2: 50-50 – half raw water and half recycled water; Stage 3: recirculation technology where all but 2 to 5 percent of the flow is recycled water. Solids removed from the water treatment processes are biologically treated in a lagoon.

Groundwater and Stormwater are Easily Managed
The hatchery forced officials to update the regional groundwater model, which dated to around 1980. "There were concerns about seawater intrusion and drawdown, but the new model did not substantiate any of these issues. As a result, we have a new model and a robust regional aquifer with enough recharge to sustain use beyond the next 50 years."

The hatchery is also designed with the latest in stormwater management techniques and is highly energy efficient. All stormwater runoff is captured, routed through ditches, and treated naturally in swales before it percolates into the ground. Roof runoff flows directly to Ship Creek, and runoff from parking lots is used for irrigation.

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METRIC SELECTION TO ESTABLISH A CONDITION GRADIENT BETWEEN NATURAL AND IMPAIRED NORTHEAST OHIO HEADWATER STREAM SYSTEMS AS A BASIS FOR EVALUATION OF RESTORATION PERFORMANCE

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When is a restoration project successful? The overarching question is one of significance to the science and practice of ecological restoration. Measuring performance is necessary to evaluate the trajectories of change with regard to a target conditional stream state as a performance goal. The basis for evaluation potentially lies within the factors influencing the concept of ecological integrity and with the assumption that a stream no matter its conditional state will have the same universal characteristics. The identification of universal measurable characteristics that sensitive to both the impaired and target condition are important to establish the conditional gradients. This research is attempting to identify and make those connections as a means to develop restoration performance metrics because there is an absence of any appropriate tools in Ohio and other areas of the country.

The multimetric development process followed these six basic steps; categorization of metrics, individual metric creation, site selection, field evaluation, data analysis and metric selection. Twelve ecological integrity factors (e.g. substrate, channel morphology, organic inputs) were selected and placed into either a Function or Structure category. The Function category was comprised of one Energy Source metric and four Flow Regime metrics while the Structure category was comprised of sixteen Habitat metrics for a total of twenty one metrics. Ultimately, the metrics need to be measureable in the field and therefore are represented by selected existing metrics from standardized methodologies such as the Qualitative Habitat Evaluation Index, geomorphic surveys and leaf pack decomposition.

Ten headwater stream sites in Northeast Ohio were selected from a group of forty potential sites. Five sites represented the target reference conditions while the remaining sites represented an impaired condition. The results at this time are still preliminary as research is still on-going. The analysis is directed at determining which of the metrics or combination of metrics are best suited to measure across the conditional continuum. Research will be complete in the Spring of 2014 but the discussion of the conceptual conditional framework and general lack of standardize performance measures or assessment tools is a topic of interest to many in the field of restoration.

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RESTORING ECOSYSTEM SERVICES IN MISSISSIPPI COASTAL WATERS BY ENHANCING SECONDARY PRODUCTIVITY USING OYSTER CULTCH AND ARTIFICIAL REEFS

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The Mississippi Department of Environmental Quality, along with its partner agency, the Mississippi Department of Marine Resources, constructed nearly 1,500 acres of low profile reef structures throughout the Mississippi Sound with the Artificial Reef and Oyster Cultch Early Restoration Projects under the Deepwater Horizon Natural Resource Damage Assessment (NRDA) Projects. The projects were designed and constructed to provide hard-bottom habitat for the colonization and production of a diverse group of fauna which live on and within these habitat types such as oysters, mussels, polychaete worms, crabs and other benthic organisms. Data on the productivity of similar reefs and habitats in the Mississippi Sound were used to calculate an offset value for the implementation of the projects. These projects were calculated to result in an increase of over 10 million kg (wet weight) of secondary productivity in the Mississippi Sound ecosystem. This increase in secondary production, that is the production of these lower food chain consumers, illustrates the role of these restorative structures in enhancing and maintaining a healthy and diverse seafood assemblage in higher trophic levels.

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SELENIUM REDUCTION IN CONSTRUCTED WETLAND TREATMENT SYSTEMS: NATURALLY ATTENUATING PROBLEMATIC POLLUTANTS

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Constructed Wetland Treatment Systems are a technology that has been used successfully for years, but has recently become more popular as green infrastructure has become an integral part of the water treatment landscape. These systems can be utilized to successfully remove metals and other constituents from storm water runoff and wastewater effluent steams. Wetlands are appealing for their passive operation, and are often lower in capital, operation, and maintenance costs than other available water treatment technologies. Constructed Wetland Treatment Systems (CWTS) have proven highly successful for removal of key pollutants, such as mercury and selenium.

As part of a strategy to achieve compliance with state water quality regulations, a major coal-fired power plant decided to design, build, and operate a pilot Constructed Wetland Treatment System to evaluate the technology to treat the plant's flue gas desulfurization (FGD) wastewater. The pilot CWTS was operated and evaluated for about one year. The primary metal constituents targeted for reduction included selenium and mercury. The pilot CWTS also performed a water polishing function with reductions in aluminum, ammonia, barium, boron, chromium, fluoride, iron, molybdenum, potassium, and total suspended solids.

Based on the findings of the pilot CWTS, these systems can be engineered to effectively reduce selenium by over 90 percent. Removal of other key constituents was also found to be successful during the pilot operation. Burns & McDonnell has designed and is currently in the construction phase of a full scale CWTS for polishing of FGD wastewater. It is our belief that this successful design can be utilized to effectively reduce selenium in other streams, such as storm water runoff and industrial wastewater.

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PERFORMANCE EVALUATION OF LARGE-SCALE ALGAL CULTIVATION FOR POLLUTION RECOVERY AND WATER QUALITY RESTORATION IN URBAN WATERSHEDS OF THE LOWER GREAT LAKES

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Restoration of urban watersheds in the lower Great Lakes region must focus on low-cost remediation of continuing and legacy non-point inputs of contaminants from the aquatic environment. Controlled land-based cultivation of benthic filamentous algae offers a remediation strategy for aquatic environments that is potentially low-cost, can be easily implemented on land of marginal value, and can potentially produce multiple benefits from water quality improvements and biomass production. The results of research into the performance characteristics and economic viability of benthic algal cultivation for contaminant removal from a Great Lakes tributary waterway are presented. Two pilot-scale cultivator raceways were installed near the mouth of the Buffalo River in Buffalo, NY and operated from April to November of 2013. Water was continuously pumped from the river and passed over a cultivated bed of benthic algae in the raceway. Weekly-harvested algal biomass samples were analyzed for total productivity, ash content, nutrient content, and metals content, and inlet-outlet water quality was sample monitored throughout. Daily average productivity of recoverable biomass for the entire season was 15.5 g DW m^{-2} d^{-1}, with a maximum weekly average of 27.3 g DW m^{-2} d^{-1}. Recoverable biomass composition averaged 76.5% ash, 10.4% carbon, 1.2% nitrogen, and 0.17% phosphorus, and also included significant measureable quantities of heavy metals. In addition, significant increases in dissolved oxygen and pH were measured between the inlet and outlet. An economic model of large-scale algal cultivation for restoration of urban aquatic systems developed using these results suggests that the cost per unit recovery for any one elemental contaminant is high, but the combination of multiple remediation and restoration benefits from a single process mitigates the prohibitive cost.

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USING STREAM METABOLIC MEASUREMENTS TO QUANTIFY RESTORATION OF ECOSYSTEM SERVICES OF IMPAIRED STREAMS PRE AND POST RESTORATION

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Through the use of re-directive in-stream structures, the physical and hydraulic conditions of a stream are directly manipulated. These structures generally perform the function of changing flow direction, redirecting energy, and causing changes in bed and bank erosion as a result of shear stress forces. These installations usually result in changing and/or developing features along the bed (e.g. pools, bars, riffles) and increasing habitat heterogeneity. While changes in the flow field over time are expected as part of natural channel evolution processes and flood flow events, understanding the level of ecosystem response to these structures, and whether or not certain ecosystem functions have truly been restored after installation have not yet fully come to light.

Stream metabolism expresses the changes in production and respiration in relative terms and can be used to measure a shift in the ecological function as a result of in-stream manipulations. The research presented in this paper builds upon earlier studies in which stream metabolism is determined in two methods for an impaired stream in Western New York, and its potential relationship to bed shear stress and flow is investigated. Two YSI 6920 V2 Sondes were used to measure dissolved oxygen (DO), resulting in a set of diel curves for two unrestored reaches and two restored reaches. Measurements of DO were made over a 24 hour period to determine day time primary productivity and night time respiration rates in the spring and the fall. This method is based on the premise that DO is directly related to the rate of photosynthesis, respiration and exchange of O_2 with the atmosphere.

The second method used metabolic chambers in controlled laboratory experiments on subsamples of stream benthos cultivated in the field. Ceramic tiles were deployed for benthic colonization at five cross sections in Elton creek to quantify stream metabolism at the same reaches. These tiles were then transferred into the lab into sealed chambers over a 24 hour period, with conditions controlled in the laboratory to simulate appropriate day and night light intensities. Specific primary productivity and respiration were determined for each sample using light and dark bottle DO measurements. Results from both experiments will be presented and compared, and a metric for measuring stream restoration using stream metabolism proposed.

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SUCCESSES AND CHALLENGES OF OYSTER HABITAT RESTORATION IN LOUISIANA

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Coastal Louisiana is experiencing rapid and continued land loss. Loss of coastal marshes threatens to diminish the ecologic and economic viability of this highly productive area of the Gulf of Mexico. At the same time oyster resources in the Gulf have been reduced both in biomass and coverage from historical levels. As a means to address both challenges, The Nature Conservancy (TNC) has engaged in several oyster habitat restoration projects at multiple locations around the Gulf of Mexico.

In Louisiana, TNC has placed four miles of constructed oyster reef material at three separate, environmentally distinct locations: Vermilion Bay, Grand Isle, and the St. Bernard marshes. The goals of these reef projects are not only to create a living oyster reef, but to realize, to the greatest extent possible, the suite of ecosystem services afforded by this habitat type. This includes the sediment accumulation, reduction of erosion rates, abatement of wave energy, and serving as a complex, structural habitat that provides forage and refuge space for finfish and invertebrates.

The U.S. Geological Survey and Louisiana State University Agricultural Center have been monitoring these restoration sites for at least two years to assess the project goals. Oyster settlement, growth and survival have varied among the three locations, largely due to the differences in the range of salinity found at each site. In general, rates of erosion at project locations are less than at unprotected, control sites. Constructed reefs do provide habitat for a range of nekton species, and data from monitoring indicate no differences with reference sites.

Naturally, monitoring has been instructive in planning for, and siting new projects, and long-term monitoring will be essential in determining the relative success of these projects.

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WETLAND RECOVERY AND SALMON POPULATION RESILIENCE: A CASE STUDY IN ESTUARY ECOSYSTEM RESTORATION

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Since 1978 a series of restoration projects in Oregon's Salmon River has restored >175 ha of emergent marsh and tidal channels, reestablishing estuary connections to >2/3 of the original wetland habitat that previously had been diked or filled for grazing and other uses. We initiated studies of Chinook and coho salmon in the basin in 2000 and 2008, respectively, to quantify life history variations within each population and to evaluate population responses to renewed habitat opportunities in the estuary. We documented considerable variation in the migratory and rearing behaviors of each species, including a diversity of estuary-resident behaviors that were rare or absent in each population before dike removal. Juvenile Chinook salmon now enter the estuary earlier in the spring (i.e., March – June) and migrate to the ocean over a wider range of sizes and times compared with the patterns that were found during a 1975-77 salmon study. Many juvenile coho salmon also now enter the estuary to rear at various times during their first year of life and do not remain in their natal streams for a full year as traditionally presumed for most coho populations. However, these life histories also were not observed in the population when salmon studies were first conducted in the basin 30 years ago.

Otolith chemical analyses indicate that juveniles with estuary-associated life histories are now contributing directly to adult salmon production in the Salmon River basin. Small salmon fry and fingerlings that migrated to the estuary in early spring and reared in the restored wetland channels accounted for 25 to 40% of the adults spawning in the basin in 2004-05. Similarly, juveniles with estuary-associated life histories contributed 20 to 35 % of the adult coho that survived to spawn in 2008-11. By re-establishing rearing opportunities in Salmon River estuary, wetland restoration has expanded life history diversity and thereby, should strengthen salmon population resilience to future disturbance.

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STOCKTYPE DEVELOPMENT AND SELECTION FOR IMPROVED RESTORATION SUCCESS IN LEBANON

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Prior to 2012, the majority of seedlings used for forest restoration in Lebanon were produced in an assortment of large containers over several years, disregarding the actual national need. Culturing techniques were inconsistent with container size, species growth habits, and outplanting objectives. These practices often resulted in the production of suboptimal seedlings and subsequent restoration failure due to additional stresses from drought, vegetative competition, rocky soils, and ungulate damage. Further complicating restoration efforts was minimal record keeping, leaving little evidence to guide improvement in seedling production and restoration outplanting practices. Currently, the Lebanon Reforestation Initiative (a project funded by U.S. Agency for International Development and implemented by U.S. Forest Service-International Programs) has developed new cost effective culturing practices that provide a basis for producing high quality nursery stock, building on both local experience and global knowledge. Science-based irrigation and fertilization practices, container selection founded on outplanting conditions, and crop scheduling are part of a planned approach that has resulted in a marked improvement in seedling quality, sustainability in seedling production and exceptionally high rate of adoption by private, community, NGO, and public nurseries. LRI has also worked closely with native nurseries to form the cooperative of native tree producers in Lebanon, strengthening their capacity to further influence reforestation policy makers at a national level. We discuss the methods, successes, and challenges of introducing new seedling production techniques to improve tree survival rate and future vision for restoration success in Lebanon.

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URBAN STREAM RESTORATION IN THE GEORGIA PIEDMONT: POLICY, PRACTICE, AND NOVEL ECOSYSTEMS

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The majority of river restoration funding is used to restore urban streams, although urban streams are impacted by anthropogenic stressors, and unlikely to regain a pristine character. Nevertheless, urban stream restoration projects are useful because they stabilize stream channels, manage storm water, and improve water quality. High impact projects also focus on improving habitat quality and aesthetics. These high impact projects have been used as mitigation banks as they provide a high return on investment. We studied restored floodplains of Clayton County, Georgia, low-order Piedmont streams, which have been the focus of an ongoing effort to improve water quality through stream restoration. Our study included analysis of soil properties, seed banks, and extant plant communities of a gradient of low-order Piedmont stream reaches in various stages of recovery and urbanization (urban unrestored, urban 10 years post-restoration, agricultural 80+ years post-restoration) over time to determine if a best practices urban stream restoration project is on a restoration trajectory toward a more pristine condition. The recently restored urban riparian ecosystem had high vegetation cover, a variety of both native and non-native species, a functioning seed bank, compacted, high nutrient soils and stream bank erosion. These results indicate that the restored urban stream shared attributes of both unrestored urban and restored agricultural sites. The study also indicates that while recently restored sites are regaining function, these may continue to show signs of dysfunction. Because we cannot completely ameliorate urban impacts, we should consider that the outcomes of urban Piedmont stream restoration attempts are the consequence of urban planning and policy. These factors ultimately result in novel riparian ecosystems capable of providing some services, but as novel ecosystems, they do not share the suite of attributes and services typical of fully functioning protected riparian ecosystems.

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A WATERSHED APPROACH TO RESTORE FLORIDA'S COASTAL COMMUNITIES

***Darryl Boudreau*[1]*, Anne Birch*[2] *and Janet Bowman*[3]**
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The Deepwater Horizon (DWH) oil spill was one of the United States' most significant environmental disasters and has resulted in several precedents, from the number of states and local governments affected by the spill, to the cost of responding to the spill, to the amount of fines and penalties that will be paid by the Responsible Parties and how those fine and penalty dollars will be spent. The DWH fines and penalties represent an unprecedented opportunity for our federal, state and local leaders and Gulf communities to change the future for the Gulf, one of the most productive bodies of water in the world.

In the end, it is expected that billions of dollars will be spent on restoring the environmental and economic health of the coastal communities impacted by the DWH disaster. These funds will be generated by the payment of criminal and civil penalties assessed on the responsible parties and spent by each of the five states impacted by the spill as well as the federal agencies involved in the spill response and recovery. Recovery from the environmental, economic and societal impacts associated with the DWH will be a long-term process. Adding to the complexity are the new rules being written at the federal level to implement the RESTORE Act.

In Florida, multiple processes are in place for stakeholders to submit RESTORE-related projects for consideration by the Counties, State, and Federal agencies, and/or the National Fish and Wildlife Foundation. These have resulted in the identification of over 850 projects accounting for more than $15 billion dollars. However, there was no unifying strategic process other than the RESTORE Act criteria in place to evaluate the contribution of each project, individually and collectively, to addressing the Gulf's needs. Working with federal, state and local governments, other NGOs and citizens, The Nature Conservancy is leading a community-based watershed approach to identify strategic projects in need of funding. The community-based watershed process identifies priority issues that affect the quality of the watersheds, from land to water, the key root causes and projects identified to fix them. A similar process is being initiated by the economic community. An outcome of these processes is to integrate the needs of the environment and economy to benefit the whole community. The plans generated will detail the key economic and environmental priorities and projects that will make a lasting change protecting and restoring the long-term health of the gulf coast watersheds and stabilizing and diversifying the economic base. This work is providing critical context for the federal and state agencies charged with allocating the DWH funds and is an opportunity to use the funding to help ensure a lasting improvement on the health of our environment, economy and gulf coast communities. Although the RESTORE funding was the catalyst, the goal is for these plans to be implemented by the stakeholders regardless of funding and jurisdictions.

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MEASURING SUCCESS IN URBAN FOREST RESTORATION

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MillionTreesNYC, launched in 2007 as part of a broad suite of initiatives (called PlaNYC) to ensure the long-term livability and sustainability of New York City, has changed the face of the urban forest. As of January 2014, over 820,000 trees have been planted in the city through this public-private partnership. Almost half of these have been planted on public parkland as part of ongoing forest restoration by NYC Parks.

NYC Parks has been actively managing and restoring forests since the early 1990s. The funding from MillionTreesNYC brought a significant shift in the extent, scale and type of restoration. We rapidly transitioned from using hand-held tools to restore sites of half an acre or less nested within surrounding canopy, to afforesting sites with no surrounding tree cover and restoring wide swathes (up to 20 acres at a time) of invaded and disturbed land using contractors and volunteers. Preliminary results from a survival study conducted by Parks staff indicate over 85% survival of newly planted trees after two years.

The million tree planting target, also expressed as a new acres of canopy target, was established in response to the ecosystem services goals embodied in PlaNYC. However, this planting target does not relate to a specific baseline number of trees or acres of canopy. Over the course of the program, not only have trees continued to senesce throughout the city, many have also been brought down in increasingly dramatic and frequent storms.

How does one begin to measure success in this context? To provide essential services, the trees that are planted need to not only successfully establish, but also to survive over the long-term, resisting invasion and either successfully regenerating or being perpetually under-planted. Members of the public need to be invested in the success of these plantings, agitate for their preservation and ongoing management, and advocate among other park users for better care of the landscape. Land owners need to be continually persuaded that these plantings provide the highest available value possible for their property, and allocate resources to managing them.

The forest restoration plantings undertaken by NYC Parks through MillionTreesNYC represent a significant accomplishment in a variety of ways. In spite of a reduction in funding, forest restoration plantings are two and a half years ahead of schedule. Invasive plant species have been controlled across 1350 acres, ensuring not only increased success of plantings, but also improving the likelihood of native sapling recruitment in these sites. Over 20,000 volunteers have participated in planting; many of these have been repeat volunteers, and research done by the USFS indicates that not only are we introducing new people to these assets, these people are more civically engaged in general as a result.

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ACCELERATING RECOVERY AFTER THE *DEEPWATER HORIZON* OIL SPILL: RESPONSE OF THE MACROINVERTEBRATE COMMUNITIES TO SHORELINE OILING EFFECTS

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The release of an estimated 4.9 million barrels of oil from the Deepwater Horizon (*DWH*) event exposed the nation's largest and most productive wetland-estuarine environment to an unprecedented potential for environmental damage. In general, oil spills can cause widespread impacts to the structure, function, resilience and sustainability of coastal wetlands depending upon oil type, volume, degree of weathering, mode of contact and other environmental and biotic factors. The goal of our project is to examine the effects that shoreline oiling has on the macroinvertebrate community of the marsh, with these macroinvertebrates serving as a proxy for marsh recovery over time. For the past year we have surveyed for marsh periwinkles (*Littoraria irrorata*) as well as fiddler crab (*Uca* spp.) burrows, as these organisms are key indicator species of overall marsh health and both species have important influences on salt marsh ecosystem structure and function. Marsh periwinkles are divided into size classes in our study (juvenile, sub-adult, and adult) to examine the size structure within sites and the possibility of new recruitment. Our sampling sites span Barataria Bay, LA, from Wilkinson Bay to Bay Jimmy and represent areas of marsh shoreline classified as reference (no oil impact), moderately- oiled (some oiling observed), and heavily-oiled (significant oiling observed). Results thus far show moderately-oiled sites to have the highest average density of *Littoraria* (82.971/m^2, p-value = 0.00057). Also, an analysis of *Littoraria* size-class distribution among across sites shows that, on average, heavily-oiled sites consist of statistically smaller individuals (p-value = <.001). This may indicate that heavily-oiled sites are beginning to receive new recruitment from smaller, younger *Littoraria*, an indication of marsh recovery following the oil spill. Our project has not yet concluded and will continue to monitor these sites over the course of the next two years to investigate possible marsh recovery.

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ESTIMATING BENEFITS OF HYDROLOGIC RESTORATION AND FRESHWATER INTRODUCTION PROJECTS IN COASTAL WETLANDS

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Ecological modeling is a useful tool for developing projects in coastal Louisiana where cost-effectiveness analyses require equitable evaluation of different project types. Comparing hydrologic restoration and freshwater introduction project benefits to shoreline protection and marsh creation project benefits is especially challenging because the benefits of importing sediments and nutrients and controlling salinity are derived from complex biogeochemical processes unlike the physical construction or protection of land. A series of desktop models have been developed to assist resource managers in the planning/evaluation of freshwater introduction and salinity management projects that allow direct comparison to benefits of marsh creation and shoreline protection projects by calculating the predicted increase in soil formation. The *NSED2* model quantifies the volume of nutrients imported as total N and P and estimates its value to organic production and annual contribution to the organic fraction of soil formation. Sediment volume is also quantified and applied to the mineral fraction of soil formation. The two components combined allow for an estimated volume benefit that is applied to the project area as fill material. In a similar formulation, the *SPROD2* model estimates the effects of reducing salinity on organic production and its contribution to organic soil formation. Until recently, both models were only available as spreadsheet applications but more recently have been developed into a simulation format (STELLA®) allowing for much more flexibility and capability with respect to data inputs. Applications of the models will be presented to demonstrate their utility in developing and evaluating coastal restoration projects.

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TROPHIC CASCADES, HABITAT FRAGMENTATION AND CLIMATE CHANGE - THE NEED TO RECONNECT, REWILD AND RESTORE TERRESTRIAL LANDSCAPES ACROSS NORTH AMERICA

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While a great deal of attention has been paid to restoring both individual landscape patches and large landscapes associated with coastal or riverine ecosystems, too little attention has been paid to the restoration or re-establishment of landscape patch connectivity and large scale migration corridors over terrestrial landscapes. And very little attention has been paid to the effects of trophic cascades on landscape health and resiliency. Climate change and the impacts associated with increasing population will continue to tax landscape connectivity.

Using scientifically based mapping and modeling efforts in combination with a robust on-the-ground community engagement initiative, the Wildlands Network is working on the conservation and restoration of two continental-scale wildways in North America; the Spine of the Continent and the Eastern Wildway. Unlike many of the large ecosystem restoration programs in the U.S that are defined by water, the primary focus of both of these initiatives is to increase protected lands and reconnect fragmented habitats that allow for the reintroduction and survival of keystone species; stem the continuing loss of biodiversity; and provide ecosystem resiliency in the face of climate change. This session will explore the on-going work of these two efforts along with recommendations on how large landscape restoration efforts can be leveraged to create a more resilient, robust and healthy landscape for people and predators.

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AN OVERVIEW OF THE DEEPWATER HORIZON INCIDENT NATURAL RESOURCE DAMAGE ASSESSMENT EARLY RESTORATION PROGRAM IN ALABAMA

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As part of the Deepwater Horizon Oil Spill Natural Resource Damage Assessment (NRDA), BP and the state and federal trustees entered into a historic agreement to fund Early Restoration along the gulf coast prior to completion of the NRDA. As part of this agreement, BP agrees to provide up to $1 billion to the trustees to fund early restoration projects.

To date, three (3) phases of early restoration have been implemented and/or proposed by the trustees. This presentation will provide a general overview of early restoration efforts in Alabama with a particular focus on wetland restoration.

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ASSESSING WATER QUALITY CHANGES DUE TO RESTORATION ALTERNATIVES: COASTA EVERGLADES, FLORIDA

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Restoration and protection of the Greater Everglades Ecosystem as intended by the Comprehensive Everglades Restoration Plan (CERP), require the correct quantity, quality, timing and distribution of freshwater deliveries, finely tuned to approach the pre-development natural system as it existed in the early 1900s. Paleoecology-based modeling (Marshall & Wingard 2012) for the 1900s indicates that oligohaline to mesohaline conditions prevailed in the nearshore embayments, and polyhaline conditions were common in central Florida Bay. Predictive salinity simulations based on FATHOM (Flux Accounting and Tidal Hydrology at the Ocean Margin) model have been developed to determine the required freshwater discharges to reduce salinity to 1900's levels (CERP 2012), but nutrient changes associated to the required discharges and salinities have not been established.

We have assessed the potential nutrient concentration changes in mangrove forest and coastal embayments of coastal Everglades and Florida Bay if the FATHOM proposed new salinity regimes were introduced by restoration. Our calculations are based upon cusum analysis of nutrient cusum data (Briceno et al., 2013) plotted along salinity gradients to track nutrient behavior from current to proposed salinity regimes. Our results indicate non-uniform spatial response of water quality to changing discharge/salinity, which in some instances suggest potential eutrophication and water quality deterioration.

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CRITICAL EVALUATION OF STREAM RESTORATION PRACTICE USING SEMI-STRUCTURED INTERVIEWS, SURVEYS AND FIELD CASE STUDIES

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To address degradation caused by past anthropogenic actions (e.g., stream channelization, installation of dams and levees), stream restoration activities have occurred in the U.S. and worldwide with the goal of returning ecosystem functions and services. As the number of projects have increased, a divide between the practitioners and research scientists has developed. Issues of contention include methods used, lack of engineering rigor, and the effectiveness of stream restoration. Before the divide between the practice and the science can be narrowed, it needs to be understood. A mixed methods approach, using field investigations, an online survey and semi-structured interviews, was used to critically evaluate the practice of stream restoration at a regional-scale. The intention was to evaluate the entire stream restoration process, including design, regulatory, construction and monitoring processes. The research characterized 1) the general practice using online survey and interview results; and 2) individual case study sites using field investigations and interview results. Incorporation of qualitative methods led to new insights on stream restoration practice by considering practitioner perspectives and experiences.

Based on interviews and the online survey, it was determined that WNY is not a site of innovation for SR, however inhibitors of innovation were identified. Major inhibitors included: 1) fear of failure/liability concerns; 2) poor communication between academic and practitioner circles; 3) poor riparian management practices and other space constraints; 4) inaccurate stereotypes; and 5) local politics. Although not a hotspot of innovation, the WNY study also provided insights into the practice-science divide. One of the emerging themes is that “science” is perceived differently by different individuals. To narrow the divide, therefore, requires research scientists to do a better job communicating how they define science and disseminating research through mechanisms easily available to practitioners (i.e., mechanisms other than peer-reviewed journal articles and academic conferences). More communication and interactions are needed between different organizations, agencies, and individuals working on and/or researching streams as there some strong stereotypes that may be broken down if different parties were interacting. These interactions could especially ease tensions between engineers and biologists/field practitioners, allowing engineers to communicate liability concerns, which are shared with many non-engineers (e.g., SWCDs, state environmental agencies) and the need for adding more rigor to the design process under present day constraints. It is also recommended that stream bank stabilization (river engineering) should be separated from stream restoration as both serve different purposes; this is especially important due to recent mitigation policy changes favoring stream restoration as a mitigation strategy. In addition, it is recommended that focusing on riparian and watershed restoration over installation of in-stream structures may ease some of the tensions stemming from liability concerns, but will require the additional hurdle of getting municipalities on board.

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RESTORATION OF AN IMPORTANT COASTAL SEABIRD HABITAT IN LOUISIANA – THE RACCOON ISLAND PROJECT

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The Isles Dernieres barrier island chain in southeast coastal Louisiana is experiencing some of the highest rates of erosion of any coastal region in the world. The rapid degradation of these islands has resulted in a decrease in the ability of the island chain to protect adjacent landward coastal marshes and swamps from the effects of storm surge, saltwater intrusion, increased tidal prism, and frequent storm waves. Raccoon Island, which is the westernmost island in the Isles Dernieres chain, serves as breeding bird habitat for a variety of avian species including brown pelicans, terns, gulls, and wading birds. It is considered the most diverse nesting colony on the coast and has supported well over 60,000 nests during peak breeding seasons. Raccoon Island is one of the three largest pelican colonies in Louisiana (several thousand nesting pair per year, with a high of nearly 6,000) and is extremely valuable for the longevity of the species. As part of the Coastal Wetland Planning, Protection and Restoration (CWPPRA) program, two projects received funding from federal and state resources to protect and restore critical avian habitat on Raccoon Island. The first project, Raccoon Island Breakwaters Demonstration Project (TE-29), constructed eight (8) segmented rock breakwaters on the eastern, gulf side of the island. Construction was completed in 1997. The second project, Raccoon Island Shore Protection & Marsh Restoration Project (TE-48), consisted of building eight (8) additional breakwaters, a terminal groin, creating 58 acres of supra-tidal, tidal, and sub-tidal habitat, and vegetative plantings. Construction has been completed on the breakwaters (2007), terminal groin (2007), marsh creation (2013) and one vegetative contract (2013). Two additional vegetative contracts are planned as part of a comprehensive approach to restore native herbaceous and woody species which provide improved breeding bird habitat and further stabilize the island.

Implications

The uses of segmented breakwaters and terminal groin have proven to significantly increase the longevity of Raccoon Island by virtue of protecting the shoreline from daily erosive wave action and frequent storm events. In addition, littoral materials recovered by these features have dramatically increased gulf-side island acreage and continues to naturally rejuvenate when storm events beneficially reposition the material onto and behind the island. Marsh creation, in conjunction with vegetative plantings, have served to restore and stabilize the bayside of the island and provide crucial nesting and living habitat for the many avian species that depend on the island for their reproduction and survival.

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DOES *WHERE* MATTER MORE THAN *HOW*?: SPATIAL CONTEXT ALTERS THE EFFICACY OF URBAN STREAM RESTORATION FOR BIODIVERSITY RECOVERY

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Restoration and maintenance of biodiversity are goals for many restoration projects. In the case of stream restorations, biodiversity recovery and maintenance is often encouraged through habitat manipulations like increasing in-stream habitat heterogeneity, restoration of natural channel morphology, and re-establishing historical connections to floodplains. Sometimes these manipulations of local stream conditions are successful, but at other times these efforts appear to have little effect. Yet while the Field of Dreams (FoD) theory of restoration has been roundly criticized for its frequent inefficacy, little tangible evidence exists for *why* the FoD often fails. However, recent applications of metacommunity theory may offer some ideas.

Metacommunity theory suggests that the processes controlling diversity actually change depending on location within a river network. Headwater streams are isolated in a river network. As a result, communities in headwater streams are structured primarily through "local" forces that include local environmental conditions and local species interactions. On the other hand, communities in more well connected sections of the network are structured by different sets of processes. Increased connectivity means that the flux of organisms into and out of these sections is much higher, greatly increasing the influence of colonization/extinction dynamics on diversity. This strong "regional" influence means that community composition and biodiversity can become decoupled from local environmental conditions. Simple extension of this well-supported idea suggests that restoration success could depend on location within a river network, with the obvious prediction that restoration will be more successful in headwaters.

We tested this prediction using a novel survey methodology in 23 stream restorations in the Baltimore area. We surveyed benthic invertebrates within the restored reach and immediately upstream of the restored reach and compared their similarities using a variety of metrics. The logic behind this method was that the regional context for the two types of samples would be exactly the same (same network position, same regional species pool) but that the local environment would be drastically different because of restoration. We predicted that 1) similarity between restoration and upstream samples would be high in headwaters but low in mainstems, and 2) that indicators of restoration success would be more obvious in headwaters. Prediction 1 was strongly supported by direct comparisons of benthic invertebrate community composition. Prediction 2 was also supported and included evidence that both diversity and community stability were significantly higher in restored headwaters, but not in mainstems. These results suggest that stream restoration can indeed promote higher biodiversity and stability of stream communities, but also suggest that the success of a restoration may be inherently limited by position within a stream network.

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1 MISSISSIPPI: CAN THE RIVER COUNT ON YOU?

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From Minnesota to the Gulf of Mexico, the Mississippi River flows through the American landscape and American life. It is a critical source of drinking water for 18 million people,
a diverse habitat for wildlife, the backbone of our economy and a rich part of our heritage. Unfortunately, the once mighty Mississippi River is in trouble. Pollution from agriculture, untreated sewage and factories along with weak law enforcement, loss of wetlands and erosion has caused our great River to decline.

The Mississippi River Network (MRN) is a coalition of almost 50 local and national organizations in the ten state Mississippi River region that have come together because of the need for river-wide cooperation to achieve large-scale, high-impact successes. Coordinated by Bluestem Communications, a nonprofit organization of communications and coalition-building specialists, MRN members share resources and implement whole River strategies, including a successful public communications campaign which grows stronger and more effective every year. Based on the first-ever public opinion research of the entire River region, "*1 Mississippi: Can the River Count on YOU?"* is a public campaign educating people about the current health of the River and motivating people to take action to protect and preserve this national treasure. The original goal of the campaign was to create a national voice for the River by recruiting 10,000 River Citizens within the ten-state River region. In 2013, the campaign reached this milestone and has taken on the next challenge to expand this community, both in size and in greater engagement of River Citizens.

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EVALUATING THE EFFECTS OF CURRENT AND POTENTIAL RESTORATION MANAGEMENT ACTIONS FOR LEAST TERNS (*STERNULA ANTILLARUM*) AND PIPING PLOVERS (*CHARADRIUS MELODUS*) ON THE MISSOURI RIVER

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The Missouri River Recovery Program has been conducting an Effects Analysis (EA) to evaluate the effects of management actions, including habitat restoration and species recovery actions, on federally listed species on the Missouri River mainstem system (MRMS). Least terns (*Sternula antillarum*) and piping plovers (*Charadrius melodus*) nest on emergent sandbars and reservoir shorelines on the MRMS, habitat which has been strongly affected by both reservoir operations and natural variability in precipitation and river flow. The objective of the EA for terns and plovers is to understand the impact of current river management on the bird populations and the effectiveness of current and potential management actions towards reducing stresses and achieving species objectives, within the context of natural variability.

The EA includes six interacting processes: 1) development of a conceptual ecological model, 2) construction of hypotheses about the effects of management actions on the species demographics, 3) collection and review of literature, unpublished data, and existing numerical models, 4) analysis and synthesis of data, 5) revisions and updates to decision-relevant numerical population models, and 6) application of the products of #3-5 to assess the hypotheses. We have found several aspects of these processes to be crucial for producing results that are both scientifically rigorous and practically useful for management planning, especially when time is limited. The framing of hypotheses required a sound conceptual model, the separation of primary hypotheses into testable intermediate hypotheses, and, as necessary, prioritization of those hypotheses to address the most decision-critical questions first. We used a systematic approach for organizing and assessing information from multiple lines of evidence to ensure that we use the best available science in a transparent manner. We developed numerical models to specifically include mechanisms affected by management actions. In this case, we have built population models in coordination with a team developing hydrological, hydraulic, and geomorphological models to better predict the dynamics of nesting and foraging habitat and the effects of flow-related management actions on those dynamics. Key to the model development process is the construction of robust, decision-relevant models that also include the full types and ranges of uncertainty, such that the impact of this uncertainty on decisions can be fully understood and used to guide future monitoring and research as part of the adaptive management process. Finally, throughout the EA we have worked to communicate the process and outcomes to managers, stakeholders, and an independent science advisory panel reviewing the process to help build broader understanding and support of management planning. Communication includes not only presentations, progress reports and discussions but also user-friendly and accessible versions of population models to allow for exploration of the outcomes of management decisions by managers and stakeholders.

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RESTORING ECOLOGICAL FUNCTION TO ZERO-ORDER URBAN STREAMS USING REGENERATIVE STREAM CHANNEL DESIGNS

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The District is riddled with eroded zero-order headwater streams and stormwater gullies, created by direct roadway runoff or by stormwater outfalls discharging to relative low points in the landscape which may or may not have been stream channels historically. In recent years, DDOE has had success in restoring these impaired resources using Regenerative Stream Channels (RSCs). DDOE has merged the results of watershed implementation plans and a stormwater outfall survey to identify all appropriate locations for this particular practice in the District. The results of this master implementation plan represent the full extent of application of this practice in one urban area. In advance of full implementation, DDOE plans to quantify the storm water detention capability of this set of restorations, and use this treatment volume to estimate the cumulative local water quality benefit.

DDOE's goals in urban stream restoration are to restore aquatic and riparian habitat, stem the flow of nutrient, sediment and stormwater pollutant loads, and delist streams from the District's 303(d) list, which is a prioritized list of waterbodies cited for local impairments to water quality, and which have been identified by the United States Environmental Protection Agency as needing Total Maximum Daily Loads. DDOE's plan for restoration of gullies and outfalls employs Regenerative Stream Channels (RSC), which stabilize degrading channels, reconnect floodplains (restoring riparian wetlands) and return native plants and plant habitats, but do not require grading back stream banks and removing numerous trees. The use the term "regenerative" in the naming of this system describes an approach to restoration which will require little to no maintenance after installation, and will develop in ecological functions over time.

DDOE has partnered with researchers from the University of Maryland's Water Chesapeake Biological Laboratory (CBL) to quantify the extent to which ecosystem functions will be restored through these treatments. CBL has been studying the ecological function of the first sets of RSCs installed in Coastal Plains locations, and has built a data set for volume detention and nutrient processing. The District's RSC study focuses on two restoration sites in the District, paired with reference streams, and collects supplementary information through a synoptic survey of eight additional sites, restored with the same treatment. For this presentation, DDOE will process the initial data on RSC performance with a model built from watershed/sewershed size, storm event load and RSC treatment areas to deliver an estimate of overall storm water volume reductions resulting from full implementation.

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BIOTIC FACTORS LIMITING OUTPLANTING SUCCESS OF THE TARGET PLANT

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Both biotic and abiotic factors influence plant performance at the outplanting site and are used to determine target plant specifications for 'fitness of purpose' in terms of morphological and physiological characteristics. In the case of biotic factors, there are three primary areas that may limit outplanting survival and growth: soil biota, competing vegetation, and animal herbivory. Certain plant traits can be controlled in the nursery production phase to help mitigate plant stresses from biotic factors. Some of these traits include plant size, nutrient status, mycorrhizal inoculation, and production of biochemical defenses. However, even with the production of the highest quality 'target' plant there are many biotic factors that cannot be addressed in the nursery phase. Thus, alterations at the outplanting site may be required to promote plant survival and growth through prescriptions such as amending soils (introduction of organic matter and mycorrhizae), controlling competing vegetation, and protecting plants from animal herbivory. The overall best approach to minimize restoration limitations from both biotic and abiotic factors is through proper site evaluations and planning.

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CREATING INTERTIDAL SUBMERGED AQUATIC VEGETATION HABITAT FROM FALLOW FARMLAND

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Manatee County acquired the 175-acre Perico Preserve property in western Manatee County, Florida in June 2007. The site was approved for conservation and passive recreational uses in 2010. The property's unique setting increases the value of restoration and provides a valuable recreational opportunity.

The goal of the project is to create a large-scale restoration project through multiple phases. Manatee County kick-started the restoration shortly after the purchase of the property through the removal of extensive cover by nuisance and invasive plant species that had claimed the majority of the upland portions of the property. Additional project phases have been designed to create and restore coastal habitats that have been lost within the region through years of coastal development and other land conversion. Habitat design was focused on providing coastal habitats that complement existing, adjacent habitats and that re-establish a presence of habitats that have been substantially lost (e.g. coastal scrub and coastal freshwater marsh).

Unique restoration objectives have also been integrated into the design. These include establishing a large diversity of native plants through direct planting and seeding, creation of high quality forage habitat for wading birds, construction of a rookery island, and excavation of a tidal seagrass basin. Many restoration projects focus on a "go-to" plant palette that includes a small assemblage of plant species. To encourage the establishment of a diverse plant assemblage typical of the proposed habitats, over 100 different plant species were specified for installation through planting nursery stock and direct seeding. Seed was collected from similar coastal habitats to ensure the plant species would be suited for the restoration site. To augment the nesting and roosting habitat for wading bird populations, a rookery island was constructed and roosting/nesting structures will be installed.

The tidal seagrass basin has been excavated from fallow farmland, requiring the removal of approximately 150,000 cubic yards of soil. The final phase includes the excavation of two tidal flushing channels that will connect the seagrass basin to Perico Bayou. Project team member, Coastal Planning and Engineering, conducted a flushing study of the proposed basin to assist in the design of the flushing channels. Once the tidal connection is established, multiple seagrass establishment methods will be evaluated to determine which methods will provide the highest success potential. Proposed methods include natural recruitment, establishment of shoalgrass (*Halodule wrightii*) using the "modified-shovel method", and the establishment of turtle grass (*Thalassia testudinum*) using the Pneumatic Plugger Method (Stantec patented).

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FORECASTING SEAGRASS AND OYSTER HABITAT RESPONSES TO 41 Y (1965-2005) OFALTERED FRESHWATER INFLOWS TO THE ST. LUCIE AND CALOOSAHATCHEE ESTUARIES

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Variations in freshwater inflow impact the salinity distributions that are important to seagrass meadows and oyster beds. The Central Everglades Planning Project (CEPP) is a first increment of the Comprehensive Everglades Restoration Plan (CERP) that aims to reduce high volume discharges from Lake Okeechobee to improve shallow estuarine habitats. CEPP daily inflow scenarios from 1965-2005 were used to generate salinity time series for the St. Lucie Estuary (SLE) and the Caloosahatchee River Estuary (CRE) on the southeast and southwest coasts of Florida, respectively. The scenarios were existing base condition (ECB), future without planning project (FWO), and alternative 4R (ALT4R). The salinity time series representative of these inflow scenarios were incorporated into oyster and seagrass models at multiple locations.

Increased salinity had a stronger influence on benthic habitats in the SLE vs. the CRE. Overall, extreme inflows were suppressed and salinity was elevated in the FWO and ALT4R relative to the ECB. However, salinity was more variable at the upstream sites in the SLE (US1 Bridge) and CRE (Cape Coral). The FWO and ALT4R scenarios increased oyster density by 1.6% and 7.6% at more upstream Cape Coral location compared to 4.0% and 4.4% at Shell Point near the mouth of the CRE. The FWO and ALT4R scenarios increased oyster density at US1 in the SLE by 3.9% and 13.7%, respectively. The generally greater salinities indicative of the FWO and ALT4R were favorable to seagrass shoot densities in both estuaries. Shoal grass (*Halodule wrightii*) at Shell Point in the CRE increased by 7.0% (FWO) and 15.5% (ALT4R). The shoot density of manatee grass (*Syringodium filiforme*) in the southern Indian River Lagoon near St. Lucie Inlet increased by 13.5% (FWO) and 20.1% (ALT4R).

The comparatively small changes in freshwater inflow under the ALT4R scenario benefitted oyster and seagrass habitats by reducing peak flow events and increasing salinity in both the SLE and CRE. While the benefit is projected for both estuaries, the CEPP coupled with the IRL South Water Reservation could provide more optimal freshwater inflows for shallow habitat in the SLE in both the dry and wet seasons.

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ENVIRONMENTAL RESTORATION OF THE LOWER EBRO RIVER AND ITS DELTA (CATALONIA, SPAIN)

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Global change due to human activity is leading to planetary-scale alterations of the climate, water cycle, biogeochemical cycles and biological communities. The impacts of global change are especially severe in freshwater and coastal ecosystems, where the intensity and rate of change are strong. In the last decades, rivers and estuaries are accumulating impacts such as eutrophication, chemical pollution, water abstraction and regulation, temperature or colonization of invasive species. All these stressors are affecting the aquatic ecosystems in a new and complex way, and its combined effects are often different in each ecosystem. We analyze the case of the lower Ebro River and Delta as an example of these complex interactions, in order to draw some conclusions about the needs of environmental restoration in times of global change.

The lower Ebro River and its delta have undergone severe impacts due to river regulation, increasing water demand, chemical pollution, eutrophication and habitat destruction. In order to reverse this status an ambitious program of environmental restoration known as Plan for the Integral Protection of the Ebro Delta (PIPDE) is being implemented with funds of the Spanish and Catalan Governments. The main goals of the PIPDE are:

Determination of environmental flows to ensure the conservation of the river, the delta and the marine system.
Ecological restoration of the river banks and islands.
Remediation of chemical pollution in the Flix reservoir.
Construction of a fish pass in the Xerta dam.
Restoration of coastal lagoons and wetlands in the delta.
Restoration of coastal environments (beaches, barriers).
Construction of wetlands for water treatment and vertical accretion in abandoned rice fields.
Improvement of freshwater supply and water quality in the bays.
Establishment of a monitoring network of environmental indicators.
The Plan is currently in its final phase of implementation and this presentation will summarize the implementation status, the expected results and the lessons learn regarding environmental restoration.

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RESTORATION STRATEGY OF MEDITERRANEAN COASTAL LAGOONS

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The main goal of the European Union LIFE Nature project *-Lagoon: Habitat restoration and management of two coastal lagoons from the Ebro Delta* (Catalonia, Spain) is to improve the ecological status of the Alfacada and La Tancada lagoons through habitat restoration and management measures, such as improvement of hydrological function, elimination of infrastructure that interferes with connectivity, and creation of new lagoon habitats in existing rice fields and abandoned aquaculture facilities.

The underlying concept of ecological status is the "distance" between the present environmental quality and pristine or, at least, near pristine conditions. The Ebro Delta coastal lagoons pristine (or reference) conditions are salt water with very low natural freshwater inputs (rainfall and extreme events of river floods). The aquatic and riparian coastal lagoons' habitats of such conditions are submerged meadows of eelgrasses (mainly *Ruppia* and *Zostera*) and glasswort (*Sarcocornia* and *Salicornia*) dominated seasonal salt marshes, respectively. Thus, the pristine biological communities are those associated with these habitat types.

Although the Ebro Delta coastal lagoons are protected as a Natural Park, the hydrological regime is altered (artificial freshwater inputs) and, subsequently, the ecological status is low. Nevertheless, some species with a high conservation value (especially birds) can only live in the Ebro Delta due to this habitat alteration. Changing the water management in order to achieve the good ecological status would be possible but incompatible with the conservation of some emblematic species. For this reason, the restoration of coastal lagoons must be analyzed case by case instead of a global and unique strategy for the whole area.

To evaluate the restoration actions undertaken in the two coastal lagoons included in the LIFE Nature project, biological indicators of both ecological status and emblematic species conservation were applied. The application of such indicators under the perspective of prioritization of different restoration strategies for each coastal lagoon is discussed. It is expected that the outcomes of the D-Lagoon project can assist in the restoration of other Mediterranean coastal lagoons.

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MEASURING FUNCTIONAL EQUIVALENCY IN RESTORED TIDAL WETLANDS: ARE WE THERE YET?

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The assessment of restoration success within tidal wetlands has received substantial attention over recent decades, although only a small portion of this effort has focused directly on functional assessment. Most of the attention on functional assessment has come from the research community, rather than regulatory-based mitigation efforts, which have been primarily concerned with simpler, structural assessments. Within the research community, functional assessments of tidal wetlands have included work on: primary productivity, food webs, biodiversity support, physical development of tidal wetlands, and soil biogeochemistry (primarily nutrient dynamics/transformations, with more recent attention on carbon sequestration). Recently there also has been growing interest in the rapid assessment of tidal wetlands; however, these efforts have focused on simple assessments of condition rather than measuring function. Additional work remains to be done linking rapid assessments to functional issues.

Within tidal wetland restoration, little effort has been made to connect assessments directly to human beneficiaries; however, there are some clear links between functions that have been measured to-date and human benefits. For example, assessments of primary productivity and especially food-web measurements have clear links to coastal fishery support. In addition, with the growing interest in carbon sequestration and the potential for regulatory carbon credits or carbon-based taxes, there are direct links here. Potential storm protection also has a strong connection to wetland development and geomorphology, as has been highlighted in a range of recent high-intensity coastal storms. Beyond these there are indirect linkages to water quality, biodiversity, and broader food web issues. In addition, the integration of landscape-scale perspectives remains a substantial challenge; one area where landscape-scale assessments are very promising is with remote sensing evaluations for primary productivity. The use of similar approaches for assessment of other functions on a landscape scale (e.g., carbon sequestration) needs further development. Restoration practitioners developing monitoring or adaptive management plans for future tidal wetland restoration projects should continue to explore indicators of function in more detail in order to improve restoration science and implementation.

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COASTAL ENGINEERING DESIGN CRITERIA FOR LIVING SHORELINES

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Living shorelines have been characterized as a shoreline stabilization technique utilizing a variety of traditional structural and biological materials. Components of living shoreline techniques have included wetland plants, oyster reefs, coir fiber logs, geotextile bags/tubes, vegetated erosion control mats, rocks, soil fill, and many others. Oyster reefs have become a large part of this topic in recent years. The implementation of living shoreline techniques has become more desirable by resource agencies, local governments, non-profit organizations, and the public due to the creation of habitat, improved water quality, and general appeal of “soft solutions” over “hard solutions”, which have been seen to cause unintended problems under certain circumstances. There have been numerous attempts to quantify the success of these techniques in various projects around the country. Unfortunately, many of these projects have been shown to not be successful due to over-expectations and limited design knowledge of the techniques.

In order to successfully design and implement these living shoreline techniques, a clear understanding of the design criteria for the project and engineering properties of the project components should be developed. These design criteria will enable engineers to understand performance characteristics and limitations as well as to optimize their designs to be more cost effective and versatile. This presentation discusses the types living shoreline projects and the design criteria that are important for successful implementation. There will also be a discussion of design parameters that are necessary for the proper engineering design of living shoreline technologies. The presentation will highlight living shoreline projects that have been implemented.

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INTEGRATING FLOOD RISK MANAGEMENT AND SALMON HABITAT RESTORATION PRIORITIES IN PUGET SOUND: GIS SITE PRIORITIZATION

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Average peak flows in most of the Puget Sound's 17 major rivers have been steadily increasing over the last 20 years. This has resulted in increased flood risk throughout the lowlands where the vast majority of residents live. Due to climate change, flood frequency in Washington State is projected to increase progressively from the 2020s through the 2080s, with the largest increases predicted for the mixed rain-snow runoff basins located in Puget Sound (*Preparing for Climate Change: Washington State's Integrated Climate Response Strategy*, April 2012).

Floodplain habitats play an important role in the life-histories of several species of Pacific salmon. Currently, three Puget Sound salmonid stocks are listed as Threatened under the Endangered Species Act: Chinook, Steelhead, and Bull trout. Development and habitat alteration in floodplains has been identified as a factor limiting salmon recovery.

Floodplains in the Puget Sound region provide a range of services that have historically been managed in isolation from each other. The high ecological and economic values of floodplains create a situation in which society places major demands on them which are often at odds. Too often, meeting one need comes at the expense of the other. Flood risk management projects get developed in ways that don't take salmon recovery into consideration or habitat projects are developed without considering flood risk. This single purpose approach can create conflicts and hamper progress. However, there is growing recognition that *flood hazard mitigation and salmon restoration are not inherently at odds with one another.* In fact, there is a significant opportunity for agencies to work together to restore habitat while reducing flood risks to people and communities.

Utilizing a robust GIS methodology for site prioritization allowed us to systematically analyze very high risk properties (Repetitive Loss/ Severe Repetitive Loss/National Flood Insurance Program claims) within Puget Sound for acquisition and/or relocation and identify management actions that could protect communities from future floods while also supporting salmon recovery efforts within and adjacent to those properties. This presentation provides a detailed description of the process developed by the GIS specialist and fish biologist to successfully integrate efforts.

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INTEGRATING WATER QUALITY AND NATURAL FILTERS INTO MARYLAND'S MARINE SPATIAL PLANNING EFFORTS

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The Chesapeake and Atlantic Coastal Bays are vital components of Maryland's culture, economy, and coastal ecosystems. These waters offer diverse habitats that support fish, waterfowl and invertebrate species, as well as a plethora of aquatic plant life. Unfortunately, stress is incessantly placed on these resources through rising coastal populations, rampant land use change, and development – all consequences of human activities. To improve the health of Maryland's estuarine systems, water quality goals were developed through a Total Maximum Daily Load (TMDL) framework. Natural filter projects offer a means of reducing nitrogen, phosphorus, and sediment inputs into the Chesapeake Bay to help meet these goals.

Through a Coastal Zone Management Fellowship, the state has taken steps to identify opportunities for natural filter projects and prioritize sites that will best improve water quality. In addition to water quality parameters, climate change was considered in site selection to maintain long term benefits. Riparian buffer, wetland restoration, and living shoreline sites are of interest because their implementation can be counted towards the TMDL water quality goals. These filters also represent one-time, cost-effective investments for the duration of each practice.

Priority riparian buffer and wetland restoration sites were identified following an extensive literature search, expert elicitation process, and spatial analysis. State-wide data were consolidated and analyzed through a geographic information system to develop county-wide targeting maps for the state's 16 coastal counties. Prioritization methods were tested at pilot subwatersheds throughout the coastal zone and areas resilient to climate change were highlighted. Alongside these efforts, living shoreline opportunities are currently being identified in conjunction with the state's shoreline stabilization screening process. The identification of priority restoration sites represents one vital tool in the state's restoration toolbox. These data can be used to narrow site selection, support funding decisions, or strengthen screening activities for natural filter projects.

In addition to natural filters at the land-water interface, shellfish aquaculture represents a novel in-situ natural filter. If adopted as a best management practice, shellfish aquaculture can contribute to water quality goals and coastal zone enhancement. Therefore, a targeting model was developed for bottom, cage, and floating cultures of Maryland's eastern oyster (*Crassostrea virginica*). Identification of potential oyster aquaculture areas may assist in water quality improvement by aiding aquaculture expansion efforts. This is a one of many steps Maryland has taken to explore the use of oyster aquaculture as a best management practice to improve water quality. By addressing aquaculture and natural filter targeting, this presentation will highlight the integration of water quality into Maryland's marine spatial planning and restoration efforts.

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PAUL S. SARBANES ECOSYSTEM RESTORATION PROJECT AT POPLAR ISLAND – BENEFICIAL USE OF DREDGED MATERIAL

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The Paul S. Sarbanes Ecosystem Restoration Project at Poplar Island (Poplar Island) is located in the upper-middle Chesapeake Bay in Maryland and is a national model for the beneficial use of dredged material. The goals of the Poplar Island project are to: restore remote island habitat in the mid-Chesapeake Bay using clean dredged material from the Chesapeake Bay navigational approach channels to the Port of Baltimore; optimize site capacity for clean dredged material while meeting the environmental restoration purpose of the project; and protect the environment around the restoration site.

Working in partnership, the Maryland Port Administration and the United States Corps of Engineers, along with a team of other Federal and State agencies, are currently restoring Poplar Island by using dredged material from the navigational channels. Approximately 68 million cubic yards of dredged material will be placed to develop 735 acres of wetlands, 840 acres of uplands, and 140 acres of open water embayment.

The wetland areas are being developed as 80% low marsh and 20% high marsh. Vegetated low marsh and high marsh areas, along with small islands, ponds, mudflats, and channels, are being created within the marshes to increase habitat diversity. The marsh areas are connected directly to the Chesapeake Bay through the Poplar Harbor using tidal openings in the dikes.

Placement of dredged material at Poplar Island began in spring 2001, and to date 177 acres of wetlands have been restored. The existing project benefits both the environment and navigation and has national recognition and public support. Lessons learned from engineering, environmental, and stakeholder interests are being applied to future wetland cell development, are being used for the expansion design and being incorporated into plans for future island restoration projects.

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LIVING SHORELINE DEMONSTRATION PROJECT – ANALYSIS OF CONCEPT PERFORMANCE

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This presentation discusses a project with a goal to establish a living shoreline that will help prevent erosion along the coastal fringe marsh of Bayou La Loutre in St. Bernard Parish, Louisiana by using the living shoreline products to attenuate the wave energy that reaches the shore. The secondary goal is to stimulate oyster growth and thereby increase the biodiversity in the immediate vicinity of the project site. To meet the project goals, living shoreline products are planned to be installed along the shoreline to reduce wave energy and stimulate oyster growth. The project is also intended to provide the Louisiana Coastal Protection and Restoration Authority (CPRA) experience and data on living shoreline products and their performance in order to design more effective living shoreline projects in the future.

To reduce marsh edge erosion, the marsh erosion tolerance to wave energy impacting the shoreline must be established to determine the conditions during which erosion will occur. Modeling and analysis was conducted to determine coastal processes at the site. An analysis of the geotechnical properties of the soil along with wave climate and shoreline morphology was used to develop the marsh erosion tolerance for the site.

The living shoreline products must reduce wave energy transmitted past the designed structure to levels below the marsh erosion tolerance limit to successfully control shoreline erosion. However, known performance characteristics of available living shoreline products are generally limited due to the experimental nature of the products. Therefore, the ability of each product to reduce wave energy transmitted past the designed structure was evaluated along with the hydraulic loading on the structures using 2D-V and 3D computational fluid dynamics modeling tools.

This presentation will discuss results of the marsh erosion tolerance analysis and the wave energy reduction performance of different living shoreline products.

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ARCHEOLOGY AND EVERGLADES RESTORATION

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People have been using and living in wetland environments for tens of thousands years. The remains left behind in archeological sites include plant and animal remains that can tell us about the past environments. In general archeologist are most often interested in knowing about what people in the past eat and how they lived, as well as the past environments that help explain earlier cultures. The remains in archeological sites include bones from animals hunted for food which reflect both the availability of the animals and their abundance. In addition the animals hunted and intently brought to the site other animals, like mice and voles, are attracted to the sites and become part of the archeological record. Plant remains can be recovered from silica plant remains) can also be recovered from the archeological soils or adhering to artifacts. archeological sites in the form of charcoal from fires along with carbonized food remains; all coming from the local environment. In some cases pollen and phytoliths (microscopic silica plant remains) can also be recovered from the archeological soils or adhering to artifacts. Archeological sites in the greater Everglades have been occupied for more than five thousand years. As such they have the potential to contain extensive information about the prehistoric Everglades environment.

The Jacksonville District of the U.S. Army Corps of Engineers has been conducting archeological investigations in wetlands across Florida in support of restoration projects for more than a decade. These have shown that South Florida wetland sites contain extensive environmental information. As part of assessing the potential effects to prehistoric sites from changes in water management associated with Everglades restoration the Corps is conducting detailed investigations of the environmental history of a representative sample of archeological sites across Water Conservation Area 3 and into the Everglades National Park. These investigations are designed to gather detailed prehistoric environmental information. This paper presents methods, types of information recovered and preliminary overview the results of these investigations.

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URBAN RIVER RESTORATION SUCCESS: COLLABORATING WITH LOCAL COMMUNITIES

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In the industrialized areas of the Northeast, restoration work on rivers involves intense interaction with municipalities, counties, states and federal agencies. Rivers know no political boundaries and attempts to restore fish passage and healthy habitats require that practitioners identify and develop relationships with the varied partners.

A successful strategy in one community may produce less than desirable results in a neighboring community. In southern New England, rivers that wind their way through densely populated municipalities have been drastically altered over three centuries by great numbers of dams that were originally installed to provide pre-industrial mill power, water supply, and recreational opportunities. While today they are frequently derelict and have negatively affected the original vitality and health of the river environment, dams are a culturally significant reminder of our shared history. Attempting to restore tidal flow or fish passage can often cause local stakeholders to be concerned and even opposed to change.

Our presentation will discuss fish passage and river restoration projects on three rivers in three communities in Connecticut: Wallingford, Bridgeport and New Haven. Each municipality posed unique challenges and opportunities for implementing restoration projects including varied funding sources, concern/support from local stakeholders and different restoration solutions. In each municipality, the local power structure can be described as a “strong Mayor” form of governance. In our experience, local governments initially seen as adversarial can serve as advocates to ecosystem restoration. Building strong relationships with the local government can make each restoration project ultimately more successful and will establish a framework for future restoration projects within the same municipality.

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DEEPWATER HORIZON OIL SPILL NATURAL RESOURCE DAMAGE ASSESSMENT EARLY RESTORATION OVERVIEW

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The Oil Spill Pollution Act of 1990 (OPA) instructs natural resource trustees to act on behalf of the public to assess injuries to natural resources and their services that result from an oil spill and to plan for restoration to compensate for those injuries. OPA further charges the trustees to develop and implement a plan for the restoration, rehabilitation, replacement, or acquisition of the equivalent of the injured natural resources under their trusteeship. Natural resource damage assessments can be prolonged and complex, in some cases lasting many years. Typically, a restoration plan is developed after the injuries to the natural resources have been studied and assessed. 'Early restoration' can be implemented prior to the completion of the damage assessment process, when opportunities arise, to achieve restoration faster.

On April 20, 2010, the mobile offshore drilling unit *Deepwater Horizon*, which was being used to drill a well for BP in the Macondo prospect, suffered a blowout, caught fire, and subsequently sank in the Gulf of Mexico. This incident resulted in discharges of millions of barrels of oil over a period of 87 days causing the largest oil spill in U.S. history. In addition, the *Deepwater Horizon* Oil Spill set into motion the largest natural resource damage assessment.

On April 21, 2011, BP and the *Deepwater Horizon* Oil Spill Natural Resource Trustees (Trustees) entered into an agreement where BP agreed to make $1 billion available for early restoration. This agreement is the largest of its kind ever reached and represents an initial step toward fulfilling the responsible parties' obligation to fund the complete restoration of injured natural resources. The Trustees are evaluating a broad suite of early restoration projects based on criteria included in OPA, the April 2011 agreement with BP, and additional factors that are key components in planning or implementing restoration projects.

Following public review and comment, the Trustees have approved two early restoration plans, Phase I and Phase II. Phase I projects include marsh restoration, oyster restoration, dune restoration, creation of artificial reefs and construction or enhancement of boat ramps. Phase II projects include enhancement of avian breeding habitat and protective improvements to turtle nesting habitat. The total estimated cost of the projects in these first phases is $71 million. In December 2013 the Trustees released a draft early restoration plan for public review and comment that included 44 projects at a total cost of approximately $627 million. Phase III of early restoration (pending acceptance by the public) will include barrier island restoration, restoration of living shorelines, oyster, seagrass and dune restoration, and restoration of lost recreational opportunities along the Gulf. The Trustees are succeeding towards securing tangible recovery of natural resources and natural resource services for the public's benefit while the longer-term process of fully assessing injury and damages is still under way.

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PORT METRO VANCOUVER HABITAT ENHANCEMENT PROGRAM

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Port Metro Vancouver, located on the southwest coast of British Columbia, is Canada's largest gateway. Port Metro Vancouver is responsible for facilitating the movement of Canadian import and export cargo in support of the Government of Canada's trade priorities, and for the safe and efficient movement of marine traffic.

Port Metro Vancouver is recognized globally as a naturally beautiful and clean port, home to hundreds of species of fish, birds and marine mammals, and more than 2.3 million people in the surrounding metropolitan region. Port Metro Vancouver's habitat projects focus on creating and improving fish and wildlife habitat in advance of port development projects, to ensure potential impacts to existing habitat can be offset.

Port Metro Vancouver is also responsible for dredging the lower Fraser River deep sea channel to support its trade objectives. The Fraser River is the largest river in British Columbia. It is 1,400 kilometres long and drains an area of 238,000 square kilometres. Port Metro Vancouver's current Annual Maintenance Dredging Program includes the removal of approximately 2.8 million cubic metres of material. Approximately one-third of the dredged materials is disposed of through ocean disposal. In keeping with Port Metro Vancouver's commitment to sustainability, Port Metro Vancouver's habitat projects, wherever practical, will reuse dredged materials that would be otherwise be destined for ocean disposal. In this way dredged material is considered a resource rather than a waste project.

This joint presentation by Port Metro Vancouver and Moffatt and Nichol will provide a case study of one of Port Metro Vancouver's proposed habitat projects, the South Arm Jetty Tidal Marsh Project. The 40+ ha area proposed for brackish marsh habitat is ideally located along a section of the deep sea channel where a significant proportion of maintenance dredging takes place. The proposed project is expected to reuse over 250,000 cubic metres of dredged materials for the benefit of creating valuable fish and wildlife habitat.

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COASTAL LOUISIANA RESTORATION PROJECT LESSONS LEARNED – 1990-2013

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The LA Coastal Wetlands Planning Protection and Restoration Act (CWPPRA) has constructed over 100 restoration projects to restore and protect nearly 105,000 acres of coastal wetlands since 1990. Some restoration techniques have worked well, others needed to be modified, while others have not been successful. Marsh restoration projects using dredged material should be constructed to achieve sediment elevations near marsh elevation after settlement, and retention levees degraded or gapped. Projects using the beneficial use of maintenance dredged material should be considered as sediment sources to reduce the costs for marsh restoration (creation) and barrier island projects. Barrier islands should be restored using suitable fill material for dunes and beaches (sands and larger grain size sediment) taken from "outside of the system" (i.e., Mississippi River, ebb tide bars, or the Gulf of Mexico). Back marsh and dune areas should be re-vegetated and retention levees should be degraded or gapped post construction. Vegetated earthen terraces should be constructed, in shallow water low wave energy environments, in suitable mineral/clay soils, 500 feet or less between terrace rows, with gaps between terrace segments, and outer terrace rows protected from higher wave energy if needed.

Rock foreshore dikes and segmented breakwaters for shoreline stabilization projects should be constructed, in suitable mineral/clay soils, with gaps between segments, close enough to the shoreline to reduce erosion, and have top elevations equal to or above high water levels. Wooden fences or geotextile sediment filled bags, installed offshore in inland lakes and bays, have not worked well at reducing shoreline wave energy in coastal Louisiana. Alternative shoreline stabilization methods to using rocks should be considered in areas with fragile organic soils (i.e., concrete panels, plastic sheet piles, plastic modules, etc.) due to rock subsidence in those soils.

Self-regulating tide gates or water control structures with electronic logic controllers should be considered to regulate hydrology (salinities and water levels) in remote locations. Water control structures should be designed with provisions (i.e., vertical slots, remote operation at night) to allow for estuarine fisheries access to protected marshes. Water control structures with motorized adjustable gates should be designed to ensure reliable operation. Modem data transmitters and monitoring data loggers should be used to transmit “real time” salinity and water level data for efficient structure operations. Hydrodynamic modeling studies should be conducted to predict the likelihood of hydrologic restoration project success. Freshwater and sediment diversions should be constructed so as not to capture the flow of the main river channel or interfere with navigation by placing the diversion channel on the non-channel side and by angling the channel away from main river flow. Vegetative plantings should be protected from high wave energy conditions, nutria or muskrat herbivory, unsuitable soils, mechanical damage by floating plants; and test plantings should be conducted in untested planting areas.

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DECLINE AND DISAPPEARANCE OF SUBMERGED AQUATIC VEGETATION IN THE RIO CRUCES ESTUARY, CHILE

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The Río Cruces wetland was formed as result of the May 22nd, 1960 earthquake in southern Chile, the largest ever recorded worldwide. The wetland was a product of approximately 2 m of subsidence associated with the earthquake that deepened the Río Cruces and flooded the adjacent floodplain. The ecology of the Río Cruces wetland was previously dominated by the invasive submerged aquatic vegetation *Egeria densa* (*E. densa*) and by the black necked swan (*Cygnus melancoryphus*) until 2004 – when both species almost completely disappeared from the wetland. The loss of the two species coincided with a regime shift from a clear water and densely vegetated wetland to a turbid water state with very little submerged vegetation.

The reduction in water depth through sedimentation resulted in a clear water system that was prone to damage by sediment re-suspension and deposition, uprooting by flows during storms and grazing by swans. Between 1960 and 2002 the average depth in the wetland decreased from 1.6 m to 1 m. Through laboratory experiments of critical shear stress, field experiments on re-suspension and numerical modeling, it was determined that the trigger depth for significant re-suspension of sediments by waves is 1 m in the north and central part of the wetland and about 1.5 m in the south part of the wetland. The 1 m trigger depth is important because it is the maximum depth to which swans can graze, potentially uprooting plants. Once the *E. densa* began to disappear a strong positive feedback process ensued whereby greater open water led to larger waves and flows which in turn resulted in more frequent and high suspended sediment concentration events and in turn this resulted in the loss of more *E. densa* and even greater open water.

Implications

The disappearance of submerged vegetation is shown to be a key driver of aquatic habitat degradation in some estuarine wetland environments. Determination of the causes of these historic changes is essential to planning appropriate management and restoration strategies. This requires careful investigation across a wide range of disciplines. The spatial and temporal patterns of decline in *E. densa* show the importance of historical sequence of events, and not just their magnitude and frequency of occurrence. For example, triggers for vegetation decline can be driven by severe storm events, but then other factors, including grazing by swans and abnormally cold and dry weather conditions, can accelerate the demise following the initial disturbance. The example presented here highlights the importance of integrated scientific investigations in determining the drivers of wetland degradation, and as the baseline for developing a coherent planning and implementation strategy for restoration activities.

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WAVE BARRIER ISLAND CHAIN RESTORATION: FROM CONCEPT TO CONSTRUCTION

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The Cat Island Chain in Green Bay, WI, is presently being restored under an initiative between Brown County and the US Army Corps of Engineers. This multi-phase project includes construction of a 4.3 mile long wave barrier along a series of remnant shoals under a $1.5M EPA Great Lakes Restoration Initiative Grant. The objectives of this restoration plan were to restore terrestrial habitat associated with the islands, to provide capacity for placement of clean dredge spoils from Federal Navigation Channel dredging activities, and to create the conditions for re-establishment of aquatic vegetation southwest of the island chain.

The Cat Island Chain Restoration is an excellent example of providing environmental benefits while promoting economic initiatives. Once fully constructed, the restoration will recreate more than 270 acres of upland habitat protecting 1,400 acres of shallow water behind the islands allowing submergent and emergent vegetation to grow for fish and waterfowl habitat. This project provides a beneficial reuse of dredge material from the outer Green Bay Harbor. Long term environmental benefits are expected as well because the near shore habitat of the lower bay will be further protected from erosion caused by storm events.

Project components included:
Geomorphic investigation to understand the long-term historic evolution of the Cat Island Chain and other neighboring features.
Development of a physical model to aid in understanding protection requirements for headlands and beach stability and understanding of overtopping characteristics.
Numerical modeling of waves, hydrodynamics, and sediment transport to understand the impact of the islands on circulation patterns and turbidity levels in the lower bay.
Determining construction issues and making recommendations for future flexibility in construction approaches on similar projects.
Refinement of the layout and construction sequencing of the islands to achieve maximum benefits for recovery of aquatic vegetation in the lee of the islands.

Planning and conceptual design began in 2001 and construction commenced in 2011. Here we will examine the design approach, along with the challenges faced by the design and construction teams, while highlighting the approaches required for successful execution of the restoration.

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THE WATER INSTITUTE OF THE GULF INNOVATION PROGRAM

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The Water Institute of the Gulf is a not-for-profit, independent research institute dedicated to advancing the understanding of coastal and deltaic systems and to applying scientific and technological solutions for the benefit of society. The Institute was founded in 2011 to build collaboration with public, private, and academic partners to preserve and protect the US Gulf Coast environment, a major source of natural, human, and industrial resources. The Institute also aims to develop, share, and promote cutting edge technology in order to advance water management efforts worldwide. The world class science and engineering incorporated in the Louisiana 2012 Coastal Master Plan will guide policy decisions as the state continues to intensify its commitment to project construction. This level of progress has highlighted other areas where advancement is needed. As Louisiana's coastal program grows and more funds become available to fund large-scale efforts, a focus on applied science and engineering must continue to guide the program. The Institute administers and continues to develop a program designed to find answers to problems that the 2012 Coastal Master Plan identified as significant but for which solutions do not yet exist. In so doing, the Institute hope to identify cost effective and sustainable ways to address the coastal crisis.

This center of innovation serves as a central point of science and engineering capacity. It must work with academic and private sector experts to maximize the applied knowledge available to decision makers. By serving as a vehicle for collaboration among the best scientists and engineers in the world, The Institute will drive innovation in coastal restoration and hurricane protection, building world class expertise in these areas. This expanded capacity will not just inform federal and state efforts in Louisiana, it will eventually create a center of science and engineering excellence that can serve communities throughout the Gulf Coast and beyond. As a center for innovation in coastal science and engineering, The Institute will help ensure that state coastal investments employ the most effective technologies and serve as models for the application of sound engineering throughout the world. The Institute seeks out and fosters innovations that could be used by CPRA or other coastal entities to achieve the most efficient, cost effective and sustainable approaches to project implementation, monitoring and adaptive management.

By formalizing an open innovation process, the Institute is fostering a culture of innovation by encouraging and stimulating out-of the box thinking and then providing a formal evaluation mechanism. The program is anticipated to continue to evolve and expand in future years. The Institute is creating and strengthening linkages between existing government entities, Non-Governmental Organizations, Economic Development Organizations, Higher Education, and the private sector to foster a coastal innovation culture, and to leverage existing broader efforts and bring them into the coastal arena.

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THE BIG RIVER WORKS

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Through *THE BIG RIVER WORKS*: *Building Cooperation to Sustain the Mississippi River System*, the America's WETLAND Foundation has convened key stakeholders in major cities along the Mississippi River for an analysis that details the consequences of inaction and outlines opportunities for cooperation that will lead to a more sustainable Mississippi River and Delta.

The five forums generated findings related to several aspects of integrated watershed management and deltaic sustainability, including: ecological, economic, and community resiliency and adaptation; restoration, protection and ecosystem valuing; community and culture; energy and economic development; resiliency and disaster protection; international cooperation and leadership support.
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COMMUNITY ENGAGEMENT THROUGH SCENARIO BUILDING WORKSHOPS

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Drawing on scenario-building techniques developed by the Department of Interior's Strategic Science Groups, The Water Institute of the Gulf is conducting a series of workshops to engage local communities in the coastal restoration process. The methodology was developed to identify critical research needs in the midst of on-going hazard events. Although Louisiana's coastal crisis is a slow moving process, the scenario building technique seemed an ideal process to identify key community concerns. The process begins with the identification of a group of 10-15 stakeholders representing the range of a community's economic interests and social/demographic backgrounds. The panel develops a series of scenarios representing possible outcomes with or without projected coastal restoration projects. The goal is to allow the community members to identify what they see as the potential cascading consequences that may occur under current conditions or following restoration projects. Ultimately, Water Institute staff will report citizen concerns to state officials.

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THE ROLE OF LOCAL IMPLEMENTATION TEAMS IN ADVANCING LONGLEAF CONSERVATION AND RESTORATION

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The Range-Wide Conservation Plan for Longleaf Pine identified a 15 year goal of increasing longleaf acreage from 3.4 to 8.0 million acres, with more than half of the acreage targeted in Significant Geographic Areas. An important principle of the Conservation Plan is that, in the absence of unlimited resources, longleaf conservation and restoration needs to be spatially focused to reach the overall goals of biodiversity conservation at meaningful scales. By targeting actions in Significant Geographic Areas, places where multiple partners are already working to conserve and restore longleaf, the greatest opportunity exists to impact longleaf restoration. These areas consistently include significant protected areas with intact longleaf pine, while also offering potential for restoration, buffering, and connectivity. Also important in the selection of Significant Geographic Areas was that the historic range of longleaf pine ecosystems be represented. It is in these Significant Geographic Areas that Local Implementation Teams have been developed to increase communication, collaboration, and longleaf conservation efforts.

Local Implementation Teams have been called the "boots on the ground" for the recovery of the longleaf pine. Team members include federal and state agencies, non-profits, and private landowners. Local Implementation Team functions are set by team partners but the purpose of the teams is to organize, plan, and deliver on-the-ground conservation actions within their self-defined geographic area, and to engage landowners with technical and financial resources to meet the overall goals identified in the Conservation Plan. There are now 16 Local Implementation Teams formed with representation in each of the Significant Geographic Areas stretching across the longleaf range from Texas to North Carolina. The development of these teams has led to increased confidence in the ability to reach the longleaf conservation and restoration goals championed by the many public and private landowners.

One of the Local Implementation Teams, the Gulf Coastal Plain Ecosystem Partnership, was formed in 1996, and now includes 12 partners that collectively manage over 1.05 million acres in northwest Florida and south Alabama. This progressive partnership demonstrates that organizations with different missions can cooperate to achieve success under a common goal of longleaf ecosystem conservation.

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EVALUATING SUCCESS ON RESTORED OYSTER REEF SANCTUARIES IN THE CHESAPEAKE BAY

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There is great interest in oyster restoration in the Chesapeake Bay. One of the key goals of Executive Order 13508 is to restore native oyster populations in 20 tributaries of the Chesapeake Bay by 2025. The benefits of oyster restoration are far beyond the obvious benefits to the economy. Restoring a self-sustaining oyster population will obviously improve annual landings for watermen. In addition, oysters, a keystone species, historically provided a large portion of the hard substrate at the bottom of the Chesapeake Bay. This substrate provides habitat for young oysters as well as other species. The filtering capability of the oyster is well-known. Oysters near the shore often act to dissipate wave energy, acting as natural breakwaters to stabilize bottom sediments and reduce erosion. With shoreline erosion a major issue in the Bay, there is an excellent opportunity for dual-purpose projects that both restore oyster habitat and incorporate green infrastructure.

In order to guide and inform oyster restoration, the US Army Corps of Engineers developed a Native Oyster Restoration Master Plan (Master Plan) for the Chesapeake Bay. The Master Plan was developed by Norfolk and Baltimore USACE Districts, in partnership with state agencies, in order to restore long-term self-sustaining populations of native oysters to the Chesapeake Bay. In addition, a multi-agency team from the Sustainable Fisheries Goal Implementation Team (GIT) including NOAA, USACE, MD and VA Fisheries Managers and oyster experts from throughout the Chesapeake Bay drafted a guide to measuring oyster restoration success titled: *Restoration Goals, Quantitative Metrics and Assessment Protocols for Evaluating Success on Restored Oyster Reef Sanctuaries*. This "GIT Metrics" report was finalized in December of 2011 and identifies both threshold and target goals at the reef and tributary level for successful sanctuary oyster reefs.

USACE Norfolk District has been constructing sanctuary oyster reefs in the Chesapeake Bay for over ten years. The two largest projects are the Great Wicomico River, constructed in 2003-2004, with 85 acres of sanctuary reef and the Lynnhaven River, constructed in 2007-2008, with 63 acres of sanctuary reef. These reefs have been monitored for the parameters defined in the GIT metrics. The results show that many reefs are meeting the threshold and even the target goals, and those that are not meeting the threshold have common attributes, such as reefs in deeper areas and/or originally constructed as less than six inches in height. This information is being used to inform future oyster restoration reef construction.

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BIWEEKLY COASTAL MONITORING USING HYDROCOAST MAPS IN THE PONTCHARTRAIN BASIN IN SOUTHEAST LOUISIANA

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The Hydrocoast Mapping Program collects a number of environmentally dynamic datasets in an effort to monitor the general condition of the Pontchartrain Basin estuary. The Hydrocoast program monitors these variables over a seven day period and produces updated maps every two weeks. The current Hydrocoast Map products include: Isohaline & Freshwater Inflow Map, Water Quality Map, Precipitation Map, and a Biological Map. All maps are posted online after completion and emailed to anyone requesting the maps.

Isohalines are mapped from real time fixed station data, but also augmented with additional, targeted field collection data from the week prior to the map release. The base map over water is recent MODIS imagery, but also maps barriers to water flow under fair weather conditions. Freshwater inflow is determined from hydrologic gauge stations or from various rating curves. All of this data, plus the cumulative knowledge of the basin hydrology, are used to interpret the isohalines. Salinity control points vary from 60 to 100 over the 6,000 square mile estuary.
Cumulative rainfall, along with wind and tide data, is taken from NOAA reporting. Water quality is mapped as actual bacterial counts or various health closures due to water quality. This data is a combination of LPBF and agency data. Recently added were water bodies listed as impaired by EPA standards for primary or secondary contact.

The Biologic Map is the most recent addition and is not fully developed. The map includes oyster bed closures or other known environmental threats to fisheries. Since June of 2013, regular aerial surveys have been conducted to monitor commercial fisheries ship fleet activity such as commercial shrimp trawling. Data is also being collected by an annual estuarine cruise which intensely samples physical and biological parameters across the estuarine gradient extending from the fresh lakes and swamps to the distal barrier islands along the Gulf of Mexico. In 2013, extensive areas of hypoxia were identified within Breton, Chandeleur and Mississippi Sounds. A key component to the success of this program is to have rapid turnaround of basin monitoring so that it has relevance to stakeholders in the basin such as fishers, but also to professional decision makers regarding the design, construction and operation of projects, such as artificial river diversions or re-introductions.

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AUTOMATED DATA ASSURANCE AND MANAGEMENT (ADAM) SOFTWARE FOR REAL-TIME QUALITY CONTROL FOR THE EVERGLADES DEPTH ESTIMATION NETWORK (EDEN)

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The Everglades Depth Estimation Network (EDEN) of over 250 real-time gages provides hydrologic data for freshwater and tidal areas of the Greater Everglades. These data are used to generate daily water-level maps of the Everglades and are used to assess biotic responses to hydrologic change resulting from the U.S. Army Corps of Engineers Comprehensive Everglades Restoration Plan. The generation of EDEN daily water-level maps is dependent on high quality real-time data from water-level gages. Real-time data are automatically checked for outliers by assigning minimum and maximum thresholds for each gage. Smaller errors in the real-time data, such as gradual drift of malfunctioning pressure transducers, are more difficult to immediately identify with visual inspection of time-series plots and may only be identified during on-site inspections of the gages. Correcting smaller errors in the data often is very time consuming and water-level data may not be finalized for several months. To provide daily water-level maps on a near real-time basis, EDEN needed an automated process to identify errors in water-level data and to provide estimates for missing or erroneous water-level data.

The Automated Data Assurance and Management (ADAM) software uses 'inferential sensor' technology often used in industrial applications. Rather than installing a redundant sensor to measure a process, such as an additional water-level gage, inferential sensors, or virtual sensors, were developed for each gage that makes very accurate estimates of the process measured by the hard sensor. The inferential sensors in the ADAM software are empirical models that use inputs from one or more proximal gages. The advantage of ADAM is that it provides a redundant signal to the sensor in the field but without the environmental threats (floods or hurricane, for example). In the event that a gage does malfunction, ADAM provides an accurate estimate for the period of missing data. The ADAM software also is used in the quality assurance and quality control of the data. The virtual signals are compared to the real-time data and if the difference between the two signals exceeds a certain tolerance, corrective action can be taken. The ADAM software is automated so that each morning the real-time EDEN data are compared to the inferential sensor signals and digital reports highlighting potential erroneous real-time data are generated for appropriate support personnel. The development and application of inferential sensors is easily transferable to other real-time hydrologic monitoring networks.

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HYPOTHETICAL WATER SURFACES FOR EVALUATING EVERGLADES ECOSYSTEM RESTORATION

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The Everglades Depth Estimation Network (EDEN), an integrated network of water-level gages and hydrologic models, provides historic and current water-surface maps for the freshwater portion of the Greater Everglades for the period January 1, 1991 to the present (2014). Scientists and water-resource managers are interested in generating water-surface maps for hypothetical hydrologic conditions that can be used to evaluate proposed management scenarios. An application named EDEN-Syn, was developed that generates synthetic hydrographs that can be used in the EDEN water-surface model to develop such hypothetical maps.

The use of the EDEN water-surface model for hypothetical hydrologic conditions is challenging because the model requires input of daily water-level hydrographs for over 240 marsh and canal structure monitoring sites. The synthetic input hydrographs also must reflect the dynamic relation of timing and magnitude between sites in order for the water-surface model to execute successfully. This challenge was addressed by using a sub-domain (subarea) model of the EDEN model domain, Water Conservation Area 3A South (WCA3AS), and thereby limiting the number of gages for the subarea. The experimental subarea water-surface model was developed that uses 31 stations from the EDEN network to generate hypothetical water-surface elevation maps for WCA3AS. Various combinations of input stations (marsh and/or canal structure), signal processing, and modeling approach were evaluated to determine the minimum number of stations that a user would need to input to the application. All the models are linear regression models and Site_64 is the only input station for the models. To generate synthetic input hydrographs, a user specifies the monthly hydrograph for Site_64 and the application generates the daily hydrographs for the other 30 sites by using the hydrograph estimation models. The synthetic hydrograph application ensures that the dynamic relations between input stations are maintained.

The application to generate synthetic hydrographs for input into a subarea model of EDEN (EDEN-Syn) adds an important utility for EDEN users to be able to simulate hypothetical water-management scenarios. Previously, EDEN had solely been used to simulate historical conditions and users could ask "what was" the water level at an ungaged location on a particular day. By generating synthetic hydrographs, users can now ask "what if" a certain hydrologic condition occurred and what would the water level be at an ungaged location on a particular day.

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USING COASTAL MONITORING DATA TO BUILD DYNAMIC REPORTS AND VISUALIZATIONS THROUGH THE COASTWIDE REFERENCE MONITORING SYSTEM WEBSITE

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Congressional authorization of the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) came in 1990 and with it came the largest coastal restoration program of Louisiana's history. The Coastwide Reference Monitoring System (CRMS) is the largest of the CWPPRA projects and is made up of 390 monitoring stations distributed across coastal Louisiana. A strategic subset of the CRMS monitoring network is made up of real time data collection stations which, along with the traditional (non-real time) CRMS stations, provide a very valuable data stream to resource managers across the coastal zone.

"Big Data" challenges will accompany any large scale monitoring effort, especially those with real time data collection. Fortunately, the CRMS project leadership had the foresight to involve the CRMS Data Management Team in all aspects of the project from the earliest days, which ensured the necessary technology resources and personnel were in place to efficiently address the "big data" issues. This approach resulted in the current release of the CRMS web application, which leverages a mapping environment to bring spatial context to dynamic reporting elements ranging from basic charts to complex down-loadable documents or report cards (http://www.lacoast.gov/crms).

Currently, real time and traditional CRMS data streams feed the data delivery, charting and reporting engines which produce a large number of downloadable data, data visualizations and data driven reports all available at the click of a user's mouse. These various data driven products provide insight into hydrologic, vegetative and soil processes at various spatial scales across coastal Louisiana. This talk will discuss the technologies and data management strategies utilized behind the user friendly web interface which brings real time and native CRMS data to the user's desktop.

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SURFACE ELEVATION CHANGE AND VERTICAL ACCRETION IN CREATED MANGROVES IN TAMPA BAY, FLORIDA, USA

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Mangroves protect coastlines, provide faunal habitat, and store large quantities of carbon (C). In South Florida and other parts of the Gulf of Mexico, large wetland areas, including mangrove forests, have been removed, degraded, or damaged. Wetland creation efforts have been used increasingly to compensate for the ecosystem goods and services lost after such removal or degradation. However, it is important that we determine whether these created wetlands are functionally equivalent to their natural counterparts with respect to the good and services they are to replace (e.g.,creating new C sinks or protecting coastal towns from recurring storms).

The ability of a wetland to store C is one of the valuable ecosystem services targeted for restoration. The long-term accumulation of soil C on created sites will be dependent in part on the response of new mangrove communities to sea-level rise, making positive soil surface elevation gain an important goal. In this study, we document change in soil surface elevation, vertical accretion, and shallow subsidence on nine created mangrove sites across a 20-year chronosequence over three years of development, and compare these to an equal number of natural reference sites in Tampa Bay, Florida. Vertical accretion and soil surface elevation change ranged from 3.7-6.8 mm yr^{-1} ($p > 0.05$) and 3.5-11.1 mm yr^{-1} ($p = 0.018$), respectively, among all nine created sites and 2.3-21.3 mm yr^{-1} ($p<0.001$) and 1.6-6.3 mm yr^{-1} ($p > 0.05$) among the nine natural sites. Sites of moderate age (created in 1998-2005), having a mix of young mangroves and marsh plants, tended to have greater soil surface elevation gain than very young sites. This may have been promoted by greater root zone expansion as the two community types mixed. Soil surface elevation on the older sites (created in 1990-1996) declined, which was likely due to a greater rate of subsidence. Older sites also had the most developed surface soils (0-10 cm) in terms of higher C (34.9-141.7 g kg^{-1}) and lower bulk density (0.41-0.66 g cm^{-3}), which may indicate enhanced potential for compaction. Based on current patterns of surface elevation change, the created sites reached functional equivalency with reference sites in approximately 18 years, which is two years prior to functional equivalency of soil C stores.

While created and natural mangroves have an ostensible ability to promote surface elevation adjustment, the processes that control soil surface elevation can switch rapidly as sites develop and forests mature. Understanding these changes will support better management strategies to promote sustainability of soil C stores and other ecosystem goods and services.

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RESTORATION OF SALT MARSHES DAMAGED BY THE 1991 GULF WAR OIL SPILL

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Healthy salt marshes of the Arabian Gulf coast provide critical forage, nesting, and resting habitat for a very wide range of species, from polychaetes to burrowing crabs, and fishes as well as resident and migratory birds. However, immediate effects of the 1991 Gulf War Oil Spill included near complete mortality of marsh fauna and fauna in many of the impacted areas. Over time, layers of algae and sediment produced a thick (at places 25+ cm) in tidal channels and salt marsh areas. This impermeable barrier precluded critical processes such as bioturbation by benthic infauna, germination by plant seeds, and subsequent re-colonization of very broad areas of salt marsh. Ten years after the spill, a 2002-2003 survey of oiled shoreline habitats recorded persistent indicators of ecological stress such as reduced abundance and distribution of key marsh flora and fauna, and degraded hydrologic regime.

The 2009-2013 Coastal Environments – Remediation and Restoration Program (CE-RRP) funded through the United Nations Compensation Commission and implemented by Saudi Arabia's Presidency of Meteorology and Environment targeted salt marsh restoration as a primary goal. The principle CE-RRP remediation activity in salt marsh habitats was the excavation of new or existing but degraded tidal channels. Channel excavation had the following key goals: (1) restore natural hydrologic regime to salt marsh habitats and reduce persistent ponding during low tide, and (2) provide channel bank and bottom substrate that was free (or exhibited reduced occurrence of) laminated algal mat and liquid or cohesive oil thus providing appropriate surfaces for colonization by marsh flora and benthic fauna.

The responses of indicators of salt marsh restoration to tidal channel excavation have been consistently positive from pilot project to demonstration project to full-scale remediation project. Three important benthic taxa, burrowing crabs, amphipods, and snails, colonized channel bank and bottom habitats up to mid-marsh elevations within weeks or months following excavation. Annual halophytes such as *Salicornia* often re-colonized channel bank habitat by the following season. These observations indicate restoration of important ecological processes.

The CE-RRP restoration design evaluated and incorporated several other remediation activities, including transplantation of mangroves (*Avicennia marina*) to channel bank habitats, and creation of "marsh mounds" from clean spoil, which also represented beneficial re-use of excavated material. Both of these activities required evaluation and mid-course correction to increase overall benefit to the project. In all, 1,800 hectares of salt marsh and tidal flat habitats were restored.

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ASSESSING AND MANAGING THE URBAN FOREST AND CALCULATING THE BENEFITS

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For many years, managing our urban greenspaces meant having grass-covered medians along medians and neutral grounds. Times have changed, and with advanced understanding for Arboriculture and new technology, we now understand the function of trees and how those functions can be recorded and monitored, and maximized through careful planning and management. The Urban Forest has become more critical to our cities and our environment. As the largest part of our landscape, trees and greenspaces often gets over looked, abused and underappreciated. Arborists and Urban Foresters along with city planners have long understood that the benefits of trees go beyond aesthetics. Trees offer our communities and our environments benefits that are measureable and tangible, and with tools such as i-Tree, these benefits can be calculated and quantified.

For years, urban trees were planted as a part of beautification projects or a method to buffer the wildlife/urban interface. The aesthetical value of trees have been enjoyed, and appreciated; however, it has been difficult to assign empirical value to trees in our urban ecology. Hospitals report that a well landscaped and treed landscape can produce a calming atmosphere, and aide in the healing of patients. In a recent article, "Lack of trees a serious health concern for Perth", Curtin University researchers have found the removal of tree canopy as part of urban infill may worsen health problems associated with climate change. Urban parks and greenspaces are enjoyed by citizens and residents of every city across around the globe. As it turns out, trees are more than just a great place to build a tree house.

To obtain the maximum benefit of the Urban and Community Forest, a municipality must first assess and evaluate the health of the trees in their city. Trees are inspected and evaluations are made through a Tree Inventory and Management Plan. A good Tree Inventory and Management Plan will give city leaders and planners guidance and will point out liabilities, issues and deficiencies within in the forest.

Calculating the benefits of the Urban and Community forest is made simple by the use of i-Tree. i-Tree is a state-of-the-art, peer-reviewed software suite from the USDA Forest Service that provides urban forestry analysis and benefits assessment tools. The i-Tree Tools help communities of all sizes to strengthen their urban forest management and advocacy efforts by quantifying the structure of community trees and the environmental services that trees provide.

Through the use of tree management tools, Arborists can better predict and understand the benefit, function and value offered by Urban and Community Forests. Through this effort, we can assign empirical data to the trees in terms carbon sequestration, oxygen production, stormwater runoff reduction, air quality benefits, etc.

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SUCCESSION IN TUNDRA LANDSCAPES AND ITS IMPLICATIONS FOR POLAR RESTORATION EFFORTS: CASE STUDY OF HERSCHEL ISLAND, YT, CANADA

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Since vegetation exerts strong controls on local ecosystem processes, understanding the effects of disturbance on short-term and long-term revegetation patterns is a critical component of understanding the resiliency of the Arctic. Arctic landscapes underlain by massive ground ice and ice-rich permafrost are inherently unstable and often display evidence of past and present thaw subsidence. With future warming and resource extraction activities, the presence and areal extent of thaw subsidence in the circumpolar Arctic are predicted to increase. In the context of restoration, this presents unique challenges for mitigating ecosystem change and developing effective restoration strategies for disturbed areas. This research investigates natural revegetation patterns following permafrost disturbance by retrogressive thaw slumps on Herschel Island, Yukon, Canada. Seven sites were chosen for the study, representing undisturbed areas in addition to 250 year old, 20 year old, and 10 year old stabilized thaw slumps. Species presence, diversity, and cover are used to describe the plant community, and the pH, organic matter content, active layer depth, and gravimetric water content of each age class' soil are presented. Results indicate that distinct vegetation communities and soil characteristics are associated with each age class, and that significant differences between undisturbed and stabilized tundra persist for centuries. This has important implications for directed restoration efforts, as the long time scale of natural recovery limits our ability to mitigate the expected increase of disturbance, let alone effectively restore these landscapes.

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WATER QUALITY PERFORMANCE OF WETLANDS RECEIVING NONPOINT SOURCE NITROGEN LOADS: BENEFITS OF TARGETED WETLAND RESTORATIONS

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Wetland restoration is a promising strategy for reducing surface water contamination in agricultural watersheds and in particular for reducing agricultural nitrate loads to the Mississippi River and its tributaries. However, adequate performance data are available for a relatively small number of full scale systems receiving nonpoint source loads, and there is considerable variability in performance among wetlands. Over the past 10 years, more than 70 wetlands have been restored through the Iowa Conservation Reserve Enhancement Program (CREP) with the explicit goal of intercepting and reducing nonpoint source nitrate loads. Under this program, wetland restorations are strategically targeted to intercept loads from 500 to 4000 acre agricultural drainage basins. A unique aspect of the Iowa CREP is that nitrate reduction is not simply assumed based on wetland acres enrolled but rather is estimated based on the measured performance of CREP wetlands. Over the past 10 years we have measured the nitrogen removal performance of CREP wetlands receiving a wide range of hydraulic and nutrient loads. Our objectives were to evaluate the effectiveness of wetlands at reducing agricultural, nonpoint source nitrogen loads and to identify primary factors controlling wetland performance. By design, the wetlands selected for monitoring span the 0.5% - 2.0% range in wetland/watershed area ratio approved for Iowa CREP wetlands. The wetlands also span a 10 fold range in average inflow nitrate concentration. The wetlands thus provide a broad spectrum of major external forcing functions affecting wetland performance: hydraulic loading rate, residence time, nitrate concentration, and nitrate loading rate. Nitrogen loads were primarily in the form of nitrate and all of the wetlands were effective in reducing both nitrate and total N loads. Nitrate removal efficiency (expressed as annual percent mass removal) ranged from 8-91% and was primarily a function of hydraulic loading rate and temperature. Mass nitrate removal ranged from 120-2800 Kg N ha/year and was primarily a function of hydraulic loading rate, temperature, and nitrate concentration. Although we observed very high nitrate removal rates, performance measures (K and K20) were near the median reported for nitrate treatment wetlands and these high removal rates would be predicted based on the hydraulic and nitrogen loading rates of the monitored systems. Our results demonstrate that wetlands can be effective sinks for nonpoint source nitrate loads across a wide range of conditions and that performance can be reasonably predicted based on hydraulic loading rate, temperature, and nitrate concentration.

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RESTORING THE LOWER MISSISSIPPI RIVER BATTURE THROUGH PARTNERSHIPS

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The Lower Mississippi River Alluvial Valley has lost almost 80 percent of its original forests and 90 percent of its historic floodplain. Demands for agricultural goods and services, navigation and flood-risk management, have shaped the economy of our nation, and although the Lower Mississippi Alluvial Valley has experienced drastic changes, it still remains a globally significant ecosystem. The wetlands of the Lower Mississippi River are recognized by the U.S. Fish and Wildlife Service as Wetland Habitats of National Concern. Additionally, the international significance of the project area's wetland values to waterfowl has been recognized by the North American Waterfowl Management Plan, the Partners in Flight Initiative, the U.S. Shorebird Conservation Plan and the North American Waterbird Conservation Plan.

The Lower Mississippi River Batture, the land between the U.S. Army Corps of Engineers mainline levee system and the Mississippi River, provides: storage of flood waters; protection for the mainline Mississippi River levee system; filtration of runoff from agricultural soils, many of which contain high levels of pesticides; spawning and rearing grounds that support an important recreational and commercial fishery; and habitat for wildlife that supports economically-important activities, such as waterfowl and trophy white-tailed deer hunting, wildlife viewing, and natural resource-based tourism opportunities.

The Mississippi River Trust and the Lower Mississippi River Conservation Committee are working in partnership with the Natural Resources Conservation Service's Mississippi River Basin Initiative to restore 40,000 batture acres to bottomland hardwood forests and wetlands in the states of Arkansas, Kentucky, Louisiana, Mississippi, Missouri and Tennessee. The project works with voluntary landowners through the Wetlands Reserve Enhancement Program to restore frequently flooded agricultural lands to bottomland hardwood forests or wetlands. Based on 2008 National Agricultural Statistics Service data, the 2.8 million-acre batture contains approximately 322,561 acres of agricultural land. The project focuses on the 699-mile reach of the Lower Mississippi River from its confluence with the Ohio River at Cairo, Illinois (River Mile 954), to the Upper Limit of the Port of Baton Rouge, Louisiana (River Mile 255).

The project began in May 2012 and more than 11,000 acres have been enrolled in the program. Reforestation of these lands will lessen nutrients entering the river and Gulf of Mexico; reduce flooding of farmland; expand habitat for waterfowl, deer and other wildlife; and increase outdoor recreation and tourism opportunities.

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ECOSYSTEM SERVICES OF RIPARIAN FOREST UNDER WATER STRESS – EXAMPLIFIED AT THE LOWER REACHES OF TARIM RIVER, NW CHINA

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The research project SuMaRiO (Sustainable Management of River Oasis along the Tarim River), founded by the Federal Ministry of Education and Research of Germany, investigates the ecological, social and economic situation along the Tarim River in Northwest China. Major objective is a Decision Support System for future management decisions in this vulnerable area.

The Tarim River is one of the longest inland rivers of the world. It runs through the hyper-arid Tarim Basin between the Taklaman and the Kuru Tag Desert. The riparian area along the river, a 'green corridor', is the Chinese hotspot for production of cotton. Since the 1950´s socioeconomic changes (growth in population, agricultural production and water abstraction) within the region led to high pressure on the ecological riverine and riparian systems. Especially the lower reaches of the river are affected by these changes. From 1970 to 2000 the lower reaches dried out.

Since then water is diverted episodically for ecological purposes. Nevertheless the riparian ecosystems are still heavily degraded, the potential for recovery is poor. But the riparian vegetation itself provides various Ecosystem Services (ESS) like ensuring of biodiversity, provision of fuel wood and timber, educational and recreational services and others. The poster will present main results of the SuMaRiO subproject *Ecosystem Functions and Ecosystem Services (ESS).*

The focus of the project is on prevention of dust transport and carbon storage. The ability of the riparian forests to provide these services is dependent on its state of vitality and therefore accordingly strongly related to the limiting factor water. Even though the main tree of the riparian forests, the xerophytic *Populus euphratica,* can resist droughts, a low groundwater level over a long period leads to degradation of forest stands. With the degradation diminishes the ability to deliver respective ESS. For example the ability to fix sand and dust from the sandy deserts in the forests. Nowadays the sand is transported easily through the 'green corridor' and accumulates on the National Highway. There is a strong connection between the ESS 'sand fixation' and the costs for artificial reed linings along the highway. The dependency between forest vitality and the ability of sand-fixation is presented.

Another important ESS is carbon sequestration. The biomass at the Tarim River is the main carbon storage in the Tarim Basin. By comparison of LANDSAT imagery the change of the carbon stored in riparian vegetation is calculated and the success of the restoration is evaluated. Furthermore soil moisture is investigated to identify forest stands which suitable for a positive development of riparian forests. The results of these investigations serve as input for the Decision Support System with focus on the ecological aspects of management decisions.

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RESTORATION OF ECOSYSTEM FUNCTIONS AT A (NEW) DANUBE SIDE CHANNEL (BAVARIA/GERMANY) – THE CRUX OF TOO MUCH OR TOO LITTLE WATER

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At the Danube river, between the two towns of Neuburg and Ingolstadt in Bavaria/Germany, a restoration project has been carried out with the main goal to bring more hydrological dynamics to the floodplain and its 1,200 ha large riparian forests. The setup of the measures is rather technical and comprises facilities for a groundwater drawdown and controlled flooding as well as a new side channel with controlled admission of stream water. This 8 km long side channel with an annual average discharge of 3 m^3/s is meandering through the floodplain and additionally serves as a bypass river around a hydro power dam to enable fish migration.

The Floodplain Institute Neuburg as partner in a scientific consortium carries out the monitoring of several parameters to supervise the success of the measures and to adapt the controlled water amounts. The parameters range from runoff, groundwater, and soil moisture to fish migration, arthropode development, and vegetation succession as well as tree vitality. The presentation will show the most important monitoring aspects, the adaption strategies for future management and lessons learned five years after begin of measures.

The main focus of this contribution is on the (im)possibility of management optimization of both aquatic and (semi-)terrestrial species. One of the main demands of the planning approval procedure was to foster the development of softwood riparian areas which are strongly protected by the European Habitats Directive. A second one is the provision of new habitats in the floodplain for fish and other aquatic species and the feasibility to migrate despite the hydro power dam – a demand of the European Water Framework Directive. The dilemma of an ecologically controlled runoff is that on the one hand as much water as possible is required for the fishes. On the other hand, however, a fluctuating water table and draw down for semi-aquatic vegetation types, especially for their new establishment, is needed. In natural environments the discharge of the main river regulates this matter naturally by its runoff conditions. If man is able to control the discharge of the side channel (to adapt the management) the two antagonistic requirements have to be brought into compliance.

The contribution shows approaches to solve this problem and gives a closer insight into restoration measures and floodplain management under European legacy.

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THE KEY INGREDIENT: MANAGING WATER FOR A SUSTAINABLE COAST

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Saving the coastal Louisiana ecosystem is a state and national imperative. Plans have been drawn, programs created, policies adopted and priorities are beginning to be set. For those plans to succeed it will be necessary to marshal the knowledge, technology, money, and political and popular will in time for it all to matter. It will also take something else, something that without which all of the other ingredients will not count for much. That key ingredient is water—fresh water.

Coastal Louisiana and the plans to save it are water dependent. Up to now those waters—river flows mainly—have been assumed to be adequate and available to achieve some meaningful for level of coastal sustainability. But water cannot be assumed, it must be planned for because it is both physically dynamic and legally dynamic. In the former case, sea level rise, climate change, and the existing consumption patterns will change both the flows available to sustain the coast and the flows needed to sustain it.

In the latter case, water is a legal thing that is spoken for by governments, tribes, individuals, businesses in ways that create rights, duties and obligations that do not change just because needs of a coast change. Understanding the importance of water in both capacities and how they might be better planned for will be the subject of this presentation.

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UTILIZING THE MRBI, THE ARKANSAS DISCOVERY FARM PROGRAM AND PARTNERSHIPS TO PROMOTE SOIL AND WATER CONSERVATOIN IN ARKANSAS

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Concern over hypoxia in the Gulf of Mexico has focused increased attention on quantifying and reducing nutrient losses from agricultural lands in the Mississippi drainage basin. Two new programs and a strong partnership among conservation partners in Arkansas have catalyzed increased activity in promoting and evaluating conservation practices that reduce nutrient losses.

First, the Arkansas Discovery Farm program was implemented in 2011 to empower agricultural producers to take additional ownership in environmental sustainability issues by conducting edge-of-field monitoring of runoff from real, working farms in Arkansas.

Simultaneously, the MRBI program, a landscape initiative, was launched to provide agricultural producers financial assistance in targeted watershed project areas to adopt and implement conservation practices aimed at reducing edge-of-field losses. A unique and innovative aspect of the MRBI was to provide producers with financial assistance to monitor the impact of conservation practices on reducing nutrient losses. Many farmers are not equipped to conduct edge-of-field monitoring.

Utilizing the Arkansas Conservation Partnership, a formal MOU among state and federal agencies and the Land Grant University, the Arkansas Discovery Farm program was utilized to provide the necessary edge-of-field monitoring for the MRBI. In addition, two other Universities, Arkansas State University and University of Arkansas at Pine Bluff, in cooperation with Conservation Districts partnered to conduct additional edge-of-field monitoring. By doing so, conservation partners decided to form the Arkansas Edge-of-Field Monitoring Network where by working cooperatively, we have been able to install over 30 automated, state-of-the art edge-of-field monitoring farms across the entire State representing all major livestock and crop operations.

Monitoring results will be presented as well as partnership outreach accomplishments that have led to Arkansas being a leader in approved MRBI projects.

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SCIENCE AND MONITORING TO ASSESS THE SUCCESS OF RESTORATION PROJECTS RELATED TO THE DWH OIL SPILL AND NATURAL RESOURCE DAMAGE ASSESSMENT AND RESTORATION (NRDAR)

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As part of the Natural Resource Damage Assessment and Restoration process, the natural resource trustees for the spill are conducting restoration activities to compensate the public for injuries from the spill. Restoration activities are intended to restore or replace habitats, species, and services to their baseline condition. To meet these goals, the restoration activities need to produce benefits that are related, or have a nexus, to the various natural resources injured and associated service losses resulting from the spill. Examples include restoring beach, dune, and back-barrier marsh nesting habitats for bird species and restoring oyster beds to compensate for lost secondary productivity. The ultimate goal of these activities is to make the environment whole for the public by restoring, rehabilitating, replacing or acquiring the equivalent of these natural resources injured by the spill.

When a specific restoration project is planned, that project has defined goals and objectives related to restoring the injured natural resource. To plan and assess the success of a restoration project, monitoring plans or frameworks are designed to measure the projects' achievement in meeting its goals and objectives. Monitoring the results of a restoration project provides the public information on compensation for the injured resource.

The natural resource trustees have a workgroup comprised of scientists from each trustee agency. This workgroup has cooperatively developed monitoring frameworks for specific types of restoration projects to assist the project in reaching their overarching objectives (for example, restoring barrier islands, living shorelines, or a resource such as birds). The frameworks are guidelines for restoration project teams, such that in project planning and design, associated science and monitoring is included to assess the success of the project related to the natural resource it is intended to restore. The frameworks also provide the potential for different projects restoring similar resources, to have data that are consistent and comparable over the long-term.

This talk presents examples of projects where restoration science and monitoring are utilized and applied in restoration planning and design to help aid in and assess the success of restoration projects.

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CARBON STORAGE DYNAMICS IN AN OLD-GROWTH, TEMPERATE DECIDUOUS FOREST: UNDERSTANDING THE BIODIVERSITY-ECOSYSTEM FUNCTION RELATIONSHIP

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In a rapidly-changing environment, understanding the relationship between biodiversity and ecosystem functionality is an ongoing challenge for ecologists. Our objective was to answer the following overarching question: Are the most biodiverse communities also those that provide the highest level of ecosystem function? Our response variable of interest was the carbon stored in the old-growth forest of Big Everidge Hollow of Lilley Cornett Woods Appalachian Ecological Research Station, located in Eastern Kentucky. Coarse woody debris (CWD, downed tree material >20 cm in diameter) was sampled across 80, 0.04 ha plots in 1989 (Muller), 1999 (Muller), and 2012 (Davis). For each sample, the following data was collected: CWD type, length and diameter measurement parameters, species, and decomposition stage. The biomass for each sample was determined using literature density values. The data were analyzed nonparametrically due to skewed distributions. CWD biomass displayed a distinct increase across the time points of 1989, 1999, and 2012. CWD biomass in the watershed averaged 27.3 Mg/ha, 33.8 Mg/ha, and 40.2 Mg/ha in 1989, 1999, and 2012, respectively. This represents a 23.8% increase in CWD biomass from 1989 to 1999, an 18.9% increase in CWD biomass from 1999 to 2012, and a significant ($p<0.05$) 47.2% increase across the study time period of 1989 to 2012. Ordinary least square and geographically weighted regression models were created in ArcMap Geographical Information Systems (GIS) to determine which factors, biotic or abiotic, were driving these changes. The models were found to be significant in 1989 and 1999 ($p<0.001$) but not 2012. Shannon diversity was found to be the only significant variable and was decreasing in model explanation as time progressed ($r2=0.19$, $p<0.001$ in 1989 and $r2=0.10$, $p=0.004$ in 1999). These results indicate that diversity has a significant impact on carbon sequestration functionality and other variables not yet explored are driving changes in CWD biomass dynamics at this site in more recent years.

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SOLICITING STAKEHOLDER INPUT TO INFORM THE PERMITTING PROCESS: MID-BARATARIA SEDIMENT DIVERSION AND RIVER RE-INTRODUCTION INTO MAUREPAS SWAMP

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The Mid-Barataria Sediment Diversion (MBSD) and the River Re-Introduction into Maurepas Swamp (Maurepas Diversion) are two of the Coastal Protection and Restoration Authority's (CRPA) Mississippi River Diversion projects currently seeking authorization from the U.S. Army Corps of Engineers (USACE), New Orleans District, through the Section 10/404 and Section 408 permitting processes. Both projects are funded through dollars dedicated to coastal restoration in Louisiana through the RESTORE Act, passed by Congress following the Deepwater Horizon Oil Spill of 2010. Previous stakeholder engagement and input for both project concepts has been collected through preparation of the 2007 and 2012 Comprehensive Master Plan for a Sustainable Coast.

CPRA solicited stakeholder input specifically for MBSD engineering and design through a Solicitation of Views package, distributed prior to submittal of the Joint Coastal Use Permit (CUP) application to the Louisiana Department of Natural Resources' Office of Coastal Management (DNR OCM). Project information, including a preliminary description of engineering features as well as a vicinity map, was provided to federal and state regulatory agencies, Plaquemines Parish, Jefferson Parish, non-governmental organizations (NGOs), Native American tribes, and Barataria Basin users. Primary stakeholder concerns included alternatives to accomplishing the project; economic impacts to industry, communities, and fishery user groups; essential fish habitat impacts; impacts to fish species and oysters; the effects to marsh vegetation and water quality from nutrients transported from the river into the basin; and flood risk/protection to communities in Plaquemines and Jefferson parishes. These concerns will be addressed through modeling and disclosed in the Environmental Impact Statement (EIS).

For the Maurepas Diversion, stakeholder comment was solicited through the Joint CUP Public Notice process. DNR OCM and USACE published a public notice that included a project description, approximate wetland impacts, and engineering drawings in newspapers and on the internet. Comments were received from federal and state regulatory agencies, St. James Parish, and NGOs. Primary concerns received included NEPA review, diversion operation, and monitoring/adaptive management.

Impacts to all resources will be disclosed in National Environmental Policy Act (NEPA) documents prepared for the individual projects.

Also to be discussed are the status of the USACE Section 10/404 permits and Section 408 requests for both diversion projects.

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EMERGING RESTORATION APPROACHES FOR DISTURBED MOJAVE DESERT SHRUBLANDS AND THE SEARCH FOR SUITABLE NATIVE PLANT MATERIALS

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Westward movement of humans during the past century has transformed the Mojave Desert. Disturbances associated with livestock grazing, recreation, utility line development, and military training are prevalent throughout the Mojave Desert, and in recent decades, wildfires fueled by the invasion and dominance of exotic annual grasses have dramatically altered habitats for sensitive wildlife species such as the threatened Mojave Desert tortoise (*Gopherus agassizii*). Despite the concern for growing impacts on the ecology of the region and their influence on human health, our understanding of how to restore the structure and function of Mojave Desert shrublands has only emerged during the past several decades.

Because natural ecological processes in the Mojave Desert are intimately tied to the timing and amount of rainfall, novel approaches that are outside the conventional restoration tool box are needed while still appreciating the complexity of this enigmatic desert. This talk delves into how process-based studies are revealing the practices compatible for this region. Techniques tested within a network of long-term monitoring sites include the use of pre-emergent herbicides to reduce the competitive influence of invasive annual grasses and enhance the native species seed bank, creating native shrub “islands” for promoting seed dispersal into vast burned areas, overcoming seed limitation through broadcast seeding, and encapsulating seeds before distribution for minimizing collection by seed-harvesting ant and rodents.

Progress continues on the testing of viable techniques for re-establishing native plants to degraded shrublands, yet limited availability of local Mojave Desert plant materials often forces resource managers to use seed stock from distant or unknown sources with only limited guidance. Consequently, relatively little is known about the genetic consequences of using such distant sources for restoring damaged desert shrublands. We developed a provisional seed transfer zone map based on climate variation within the region. In a multi-agency collaboration, we are testing the efficacy of the map for a variety of species in multiple common gardens distributed throughout the Mojave Desert where morphological, physiological and genetic studies will inform plant materials selection for restoration. Collectively, studies of restoration techniques and development of seed transfer zones will not only assist restoration practitioners as the Mojave Desert is faced with increasing development for alternative energy, but will help practitioners plan for restoration as our regional climate continues to change.

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USING MENTAL MODELING AND COMMUNICATION AUDITS TO LINK ECOSYSTEM SERVICE VALUATION TO RESTORATION GOALS

*Christine Feurt[1], Kristin Wilson[1], Tin Smith[1], Suzanne Kahn Eder[1], Jeremy Miller[1], Sue Bickford[1], Rob Johnston[2], **Verna DeLauer**[2], Peter Wiley[3]*

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Stakeholder groups responsible for managing and restoring riparian buffer structure and function have limited economic information on the value of these systems. Local, state and federal agencies, watershed groups and land trusts in this stakeholder group approach their work through a predominantly biophysical lens with incomplete understanding of the theories, methodologies and frameworks applied by ecological economists. This research aims to open that lens to include an economic perspective. A mental models approach and communications audit was used to assess stakeholder understanding of ecosystem services and tradeoffs and to develop explicit strategies for bridging communication barriers between academics of different disciplines and practitioners. This research was conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services. A grounded theory approach using focus groups, participant observation, qualitative interviews and a regional survey revealed dominant themes related to private property rights, a stewardship ethic, and disparities in values related to land tenure. Adapting the current narrative used by managers to reflect this new understanding of constituent groups values and attitudes is being used to improve messages and dialogues about trade-offs to policy makers.

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MAKING THE CASE FOR BRINGING NATURAL INFRASTRUCTURE TO SCALE

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There is growing evidence that natural defenses, also called natural or green infrastructure (healthy reefs, living shorelines, dunes, floodplains, marshes and forests), can reduce risk to life and property in ways that meet the multiple needs of communities, public agencies, and private industries better than gray infrastructure alone. To bring nature-based risk management into the mainstream, it is necessary to promote mixed natural and gray disaster risk reduction solutions to improve the triple bottom line of social, economic, and environmental benefits.

Natural infrastructure can make people and their communities safer and more resilient by providing other important benefits like clean water, healthy environments, and green spaces for recreation. Places and ecosystems can be restored in ways that help reduce risk and improve resilience. Economies can be enhanced by guiding smart development and investments to reduce damages from natural disasters. In light of these combined benefits, natural infrastructure is a win-win-win approach for risk reduction and improved resilience for communities and nature.

Unfortunately, the biggest barrier to change when it comes to managing risk, is that the market tends to only see value in gray infrastructure. Existing financial, legislative and cultural norms often favor man-made barriers over natural defenses (e.g. oyster reefs, floodplains, coastal wetlands, etc.) and so natural infrastructure rarely enters the conversation. This talk aims session will examine planning and restoration efforts and how large-scale restoration projects and programs are engaging national and international engineering firms to help. It will provide context to participants on the science and engineering of coastal defenses, what we do and don't know. Participants will also receive guidance on sources of information that help make the case to decision makers for nature-based approaches and eco-engineering options.

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SCHOHARIE COUNTY STREAM RESTORATION PROJECT: RESTORING NATURAL STREAM FUNCTION

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In 2011, Hurricane Irene and Tropical Storm Lee, spaced only ten days apart, caused severe flooding throughout the Northeast, impacting much of the area's infrastructure and natural waterways. In early 2012, as part of the United States Department of Agriculture Natural Resources Conservation Service (NRCS) Damage Survey Report process, eight sites were identified in Schoharie County, NY, encompassing approximately 50,000 linear feet of potential stream restoration. The eight reaches are located along four streams that were severely impaired due to the significant loss of riparian buffer and erosion of associated banks and floodplains.

The restoration work is being jointly funded by NRCS and Empire State Development for Schoharie County. As the selected design consultant, AECOM's approach to the stream restoration strived to address the complexity of causes and satisfy multiple goals. The design approach considered both the overall watershed issues and the individual needs of each reach.

During design development, the causes of impairment were diagnosed and the degradation extent was quantified. Habitat and biological assessments of the sites were conducted; this information was used along with land use, topography, drainage networks, soils, and other data to identify watershed issues that affect and interact with the existing channels. Riparian morphology was evaluated, assessing microtopography, vegetation composition, vegetation hydroperiods, and woody debris. Sediment competency and capacity calculations were performed for each stream's sediment regime. Soil borings were conducted to determine the structural characteristics of soils. The streams were characterized based on their geomorphic and hydrologic parameters, serving as the basis for a natural channel design approach.

H&H modeling was performed to evaluate the watersheds' conditions. Hydraulic models were used to help determine the bankfull discharge based on the field-identified bankfull indicators. Peak discharge rates were modeled and flood stages associated with the different flows were simulated. Potential shear stresses were established for the design storm conditions.

The design intent was to create a stable channel within the valley, establish bedform diversity, and provide for in-stream habitat variety. The natural channel design included bioengineered structures to provide for slope, bank, and channel stabilization, as well as habitat enhancement. The restorations were designed to reconnect the bankfull channel to active floodplain, protect adjacent structures and infrastructure, and restore the riparian vegetation lost and/or impaired. This presentation will describe the fast-paced design completed in less than nine months, as well as showcase the project construction, expected to be completed in 2014.

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ASSESSING ECOSYSTEM FUNCTIONAL EQUIVALENCE BETWEEN CONSTUCTED AND NATURAL OYSTER REEFS WITH STABLE ISOTOPES

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Two year experiments were conducted in three Mississippi Sound tributaries (Bayou Cumbest, Crooked Bayou, and North Rigolets) to compare the faunal colonization of constructed *Crassostrea virginica* oyster reefs with the faunal assemblage at natural reefs. Stable isotope values (^{13}C and ^{15}N) of all fauna from paired artificial and natural reefs were measured every 6 months to determine if these reef types are equivalent in terms of ecosystem function from a food web perspective. Results from the first winter sampling showed that constructed reefs had a more diverse assemblage than natural reefs within 5 months with a higher proportion of various crabs and amphipods at all three sites. Organisms that were common to natural and constructed reefs (oyster seedlings and spat, barnacles, polychaetes, and mud crabs) had similar ^{13}C and ^{15}N isotopic values between reef types. The trend of greater diversity at the constructed reefs continued throughout all sampling times with the highest diversities observed during the spring samplings. During the first spring (2007), top predator fishes were only captured at the Bayou Cumbest (most inland) site with *Hypleurochilus mutlifilis* (Featherduster Blenny) and *Ctenogobius boleosoma* (Darter Goby) having the highest del ^{15}N values (10 and 12 per mil, respectively) at the natural site and *O. beta* (Gulf Toadfish; ^{15}N = 10 per mil) at the constructed site. The highest ^{15}N values at the other sites during the first spring were barnacles and chironomid larvae (^{15}N = 8 to 9 per mil), *Myrophis punctatus* (Speckled Worm Eel) (^{15}N = 9 per mil), and Eunicidae polychaetes (^{15}N = 10 to 11 per mil). After 1.5 years (2007 winter), adult oysters were found at the constructed sites and all oyster age classes continued to show nearly identical ^{13}C and ^{15}N values between paired natural and constructed reefs. During this winter sampling, barnacle and polychaetes (Eunicidae and Pilargiidae) occupied the highest trophic level (^{15}N = 8 to 11 per mi). The final spring sampling (2008) had the highest diversity of fauna during the experiments. High trophic level fish were again primarily found in Bayou Cumbest with the highest diversity and ^{15}N values at the constructed reef where Gulf toadfish, *G. bosc* (Naked goby), and *G. strumosis* (Skilletfish) had del ^{15}N values of 10.7 to 11.5 per mil whereas the only fish at the natural site was Darter Goby with a del ^{15}N value of 9.6 per mil. Aside from these fishes, the faunal assemblage and isotopic values between the natural and constructed sites were similar suggesting that artificially constructed reefs located near existing reefs can become functionally equivalent to their natural counterparts within two years.

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CHALLENGES FACING SHRUBLAND REHABILITATION ON THE ARID ARABIAN PENINSULA: INSIGHT GAINED THROUGH PRECISION-SEEDING AND GREENSTOCK TRIALS

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The Arabian Peninsula, like other arid and semi-arid regions of the world, is characterised by a highly variable precipitation regime with extended dry periods between episodic rainfall events. Seedling recruitment varies across species with annuals recruiting more frequently than perennials, with the latter perhaps as infrequently as once per decade. Recruitment is dependent on many factors including dispersal of viable seed, soil moisture, soil surface processes including barriers to emergence, and the ability of roots to access at-depth moisture. In recognizing these and related constraints on recruitment, we are investigating *Acacia* shrubland rehabilitation from two complementary perspectives: precision seeding and greenstock installation.

Precision seeding-based rehabilitation has potential provided edaphic factors such as soil texture, mechanical impedance, infiltration rate, moisture retention, and seed burial depth are taken into account. Sand-dominated soils, those similar to natural wadis where recruitment occurs most frequently, have been most suitable for precision seeding because mechanical impedance is low, water easily infiltrates to depth in the profile, and emergence is not restricted by hard-setting surface crusts more common in soils with greater clay content.

Precision seeding: Greater germination and emergence have been noted for seed sown at 2 cm rather than 1 cm because desiccation is too great at the shallower depth. As clay content increases, however, shallower sowing is possible due to greater moisture retention, but with this comes the potential for surface crusting. Gravel should increase rainfall effectiveness. However, when gravel is minimally present and mixed with fine-textured clay it provides no benefit. In this case the presence of a large medium-coarse sand fraction in preferred sites negates the clogging effect of fine-textured clay allowing for greater infiltration, minimal surface crusting and less restricted emergence.

Greenstock: The study involved five species of *Acacia*, seven irrigation regimes, 17 plant treatments, 2 planting phases, and the installation of >75,000 container-grown seedlings. While the study is ongoing, initial indications are that plants adjust to seasonal drought through leaf-drop and subsequent re-greening with the onset of winter rain. Though irrigated plants continue to grow, the higher than expected survival of unirrigated plants may provide a more cost-effective option for rehabilitation.

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APPLICATION OF LIVING SHORELINE STABILIZATION METHODS TO PROTECT COASTAL SHELL MIDDENS IN MOSQUITO LAGOON, FL

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Over the past sixty years, a combination of natural and human impacts has resulted in the destruction and alteration of shoreline habitats around the world. The loss of intertidal habitats represents a loss of valuable ecosystem services, such as shoreline stabilization, water filtration, and habitat for marine and terrestrial fauna, including economically important species. Hard-armoring techniques (i.e. sea walls, rip-rap) are often used to replace native communities to control erosion. However, hard-armoring methods require maintenance and eventual replacement, disrupt the link between terrestrial and estuarine habitats, and reduce habitat for native species. An alternative to hard-armoring methods include soft-armoring or living shoreline techniques. This restoration methodology is a type of biomimicry and utilizes native plants and animals to restore the natural structure and function of the shorelines.

In Mosquito Lagoon, FL, located at the transition from temperate to sub-tropical zones, intertidal communities consist of oyster reefs in front of a diverse vegetative community, including *Spartina alterniflora* (halophytic grass) and three species of mangroves. Beginning in 2008, we scientifically tested living shoreline techniques and found a multi-species approach with oyster shells and plants reduced erosion along major boating channels. We applied our living shoreline methodology to protect Turtle Mound, a Native American shell midden, experiencing severe shoreline erosion. In April 2011, volunteers deployed 1140 oyster shell mats, 622 *S. alterniflora* transplants, and 450 mangrove seedlings (*Rhizophora mangle* and *Avicennia germinans*). Significant decreases in rate of erosion occurred over time with recruitment and growth on the oyster mats and increases in plant cover. Oyster recruitment occurred within six months of mat deployment, with a mean (±SE) number of oysters of 72.8 ± 5.0 per m^2 after two years. Mean percent cover (±SE) of *S. alterniflora* and mangrove species increased from less than 3% before stabilization to 42.0 ± 6.4 % and 42.2 ± 5.2 %, respectively, after two years. Building on the success at Turtle Mound and applying lessons learned, we used adapted methodologies to construct living shorelines at five additional shell middens in 2012 and 2013 and stabilized an additional 80 m of shoreline at Turtle Mound. At these sites, significant decreases in rates of erosion have occurred, with some sites accreting sediment up to 4 cm within six months of living shoreline construction. Plant cover increased significantly and ranged from 20% to 50% in six months and up to 75% for sites over 1 year post-restoration. To date, we have successfully engaged the local community in 721 meters of living shoreline stabilization in Mosquito Lagoon, with over 5000 volunteers contributing more than 11,000 hours of community service. On-going monitoring allows for continued evaluation and adaptation of our science-based approach to living shoreline stabilization and guides current and future projects.

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A "CAMPAIGN" APPROACH TO OUTREACH AND INFORMATION USING MEDIA ACROSS MULTIPLE PLATFORMS TO MAXIMIZE AUDIENCE AND IMPACT

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This session will provide attendees with practical information, strategies, and ideas to reach core constituencies through compelling communications that enhance the profile of your project while galvanizing support. We start with a methodology for determining the important parameters of a communication campaign such as purpose and intended outcomes, essential messages, audience characteristics, obstacles and barriers, constraints, distribution venues and platforms, and evaluative measures. Up-front analysis and planning makes for a more precise, predictable, and effective communication effort.

In considering the content — the actual messaging — of a communications effort, there are some very important considerations, such as story, the human interest factor, positive and hopeful outlooks, inviting vs. inflammatory words, benefits, and preferred topics. Years ago, Marshall McLuhan posited that the “medium is the message.” But now, crafting the message to both the audience and the medium is essential for impact and for effectiveness. Model communication campaigns convey information and elicit response by connecting emotionally as well as intellectually with their target audience. It is critical to know what strikes people viscerally about a project and how it creates value for them. Learn how to cast your project in narrative, in story, across multiple media platforms.

We will take an in-depth look at a government agency’s campaign approach to sharing its important species recovery work with the public, with civic leaders and legislators, and even with detractors. Although this was a very large project that continues to this day, it had a tiny communications budget. Yet, it managed to create multiple stories with national and international coverage, news feeds, broadcast programs, social media followings, web videos, and even a live webcam experience. This, despite project ups and downs, naysayers, and the usual bureaucratic snafus.

Finally, let’s get real. Professionally produced media communications costs money. What can be done if a) there is no money, b) there isn’t much money, c) money is slow to arrive. We’ll look at low-cost solutions, at DIY solutions, and how to improvise creative solutions. Staff members, interns, college students, public access TV stations all provide sources of creative and technical talent. And with so many distribution channels hungry for content — the web, news organizations, blogs, membership organizations, community TV, public TV, educational institutions, film festivals, to name a few — there is an endless opportunity to get your campaign style communications initiative in front of the people you want.

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NATURE-BASED SHORELINE RESTORATION TECHNIQUES

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In the 3.8 billion years that life has existed on Earth, nature has developed brilliant solutions to its own challenges. When it comes to protecting shoreline communities of plants and animals, nature's solutions have included dunes, wetlands, reefs, floodplains and other vegetated habitats. Ever evolving and adapting to changing conditions, nature's solutions typically deliver stacked benefits like habitat, erosion control, and filtration.

To protect human communities and threatened habitats, many have taken inspiration from nature's genius to create "living infrastructure" that attempts to deliver the same kind of benefits. When viewed and treated as a living system that is not separate from humans, nature-based designs deliver much more than you ask of them. But these living systems are amazingly complex; attempts to recreate them are often not well understood and can suffer from budget or time constraints. In addition, these nature-based tools can be very expensive, difficult to maintain, and, in some instances, may not be resilient in the long term. Many are beginning to look at "coastal green infrastructure" tools as a panacea for what ails our threatened coasts.

This presentation focuses on constructed coastal green infrastructure project experiences from the past 30 years, showing what works and what should be avoided. Projects examined include living shorelines, floating wetlands, tidal wetlands, oyster reefs, dune habitats, and floodplain management. The goal of the session is to provide practitioners with practical knowledge that will help them hone in on the tools that are most appropriate and effective for specific coastal situations.

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ENHANCING ESTABLISHMENT OF WHITE OAK AND AMERICAN HAZELNUT ENRICHMENT PLANTS IN A MESIC FOREST USING UNDERSTORY REMOVAL AND GROUP SELECTION

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In the absence of periodic disturbance, primarily fire, many oak-dominated woodlands in the Eastern and Midwestern United States are transitioning to sugar maple (*Acer saccharum*) dominated communities. This experiment was conducted to determine the effects of forest overstory and/or understory removals on enrichment plantings of white oak (*Quercus alba)* and American hazelnut (*Corylus americana)*. The combination of prescribed forest canopy openings and understory tree removal significantly increased mean twig elongation, an indicator of overall growth and vigor, of white oak as compared to control trees. A similar pattern was seen in the hazelnut, with the two treatments that included a group selection opening offering a significant growth advantage over the treatment which only included understory clearing. Group selection openings in this study were small (250 m^2) compared to previously recommended canopy openings of 1,000 m^2 or more, suggesting that oak and hazelnut regeneration may be enhanced without the dramatic visual impact of more intense silvicultural practices of clearcutting and shelterwood and when using large planting stock (> 1.5 m in height or 2.5 cm caliper for oak and 3-4 year old containerized hazelnut). As such, successful oak and hazelnut establishment and growth may be possible in intensively-managed, frequently-visited forest preserves where maintaining site aesthetics is a high priority.

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THE EFFECTS OF CORAL GENOTYPE ON RESTORATION SUCCES IN THE THREATENED CARIBBEAN STAGHORN CORAL, *ACROPORA CERVICORNIS*

Crawford Drury *and Diego Lirman*
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Massive losses of Acropora cervicornis throughout the Caribbean in the past several decades have prompted a move toward active restoration as a means of partly mitigating these declines. One focus of these restoration practices involves the coral gardening technique, where small portions of wild colonies are collected and reared in an underwater nursery before being used to restore degraded reefs. Accurate information on coral genetic and genotypic diversity is needed to help guide the science-based restoration process and maximize the likelihood of species recovery.

Genotyping by Sequencing (GBS) indicates that genetic diversity of Acropora cervicornis is as high on a single wild reef on the Northern Florida Reef Tract as within a nursery of collections from multiple reefs that were deliberately selected to avoid clones. This indicates that inbreeding depression should not be a concern during the restoration of Acropora cervicornis over moderate spatial scales. Furthermore, colonies show a continuum of growth rates based on coral genotype within the nursery and subsequently when returned to wild reefs. Site selection plays a strong role in coral growth rates, with differentiation based on genotype within sites occurring more quickly at deeper restoration sites. Pooled results do not show significant differences in genotype across all sites. These 'winners' with high growth rates in the nursery and at certain sites do not necessarily grow most quickly at all sites, highlighting the interactive effects of environment and genotype. Branching rates differ based on genotype (and thereby original collection site) regardless of site, showing that overall linear extension may be more flexible and potentially adaptable than morphological patterns.

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GEDDES BROOK AND NINEMILE CREEK CHANNEL AND WETLAND RESTORATION AT ONONDAGA LAKE

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Ninemile Creek is a major tributary to Onondaga Lake, located in Syracuse, New York. Geddes Brook is the last major tributary to Ninemile Creek before it enters the lake. The brook and lower part of the creek were the pathway for historical industrial discharges. A ROD was issued for Geddes Brook and Ninemile Creek in 2009. The remedy includes removal of contaminated material followed by placement of a habitat layer to support resident fish and benthic macroinvertebrate species. The remedy also calls for relocating Geddes Brook and a portion of Ninemile Creek to facilitate remediation and channel and wetland restoration.

Anchor QEA developed a HEC-RAS model to support developing channel restoration designs and water budgets for adjacent wetland areas. In addition, an HSPF model was developed for Geddes Brook to provide hydrology for the HEC-RAS model. The HEC-RAS model was updated with recently acquired high-resolution bathymetry and topography and calibrated using USGS gage data. Model outputs for high and low flow scenarios were used to evaluate water surface elevations, water depths, and calculate stable particle sizes. The stable particle sizes were compared with the habitat suitability index (HSI) requirements for fish species present in the creek to develop designs for the habitat and erosion protection layers.

The HEC-RAS and HSPF models were also used to develop a detailed water budget to floodplain wetlands. The wetlands receive most of their hydrology from spring floods and snow melt and various design alternatives were investigated to optimize hydrologic inflow during the growing season to create deeper water to reduce the chances for colonization by *Phragmites australis* (an invasive species). Water surface elevations and flood frequency were used to delineate habitat types to be restored within the stream corridor and floodplain.

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INNOVATIVE SOLUTION FOR COASTAL FISH NURSERY RESTORATION

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The post-larval stage is the final stage of the pelagic larval phase in the life cycle of reef-dwelling coastal marine animals. These fish and invertebrates settle in shallow, sandy or rocky onshore habitats to protect themselves from catastrophic predation. In an intact onshore habitat, more than 90% will naturally die within the first week of their return, but without adequate natural habitats, the survival rate can decline to zero!

Young of the Year (YOY) gathered in these shallow habitats are seeking nurseries, defined as possessing 3 mandatory attributes: 1- presence of other congeners (high density), 2 - presence of suitable food, and 3- presence of refuge which limits predation. Unfortunately for young recruits, shoreline modifications such as bulkheads, harbors and piers, are increasingly prevalent, directly affecting their essential habitats. Mitigation for the impacts occurring during this lifecycle stage is crucial to restore the connectivity and life cycles of aquatic populations.

Various types of artificial micro-habitats called Biohut® have been introduced to damaged areas as a substitute for the role played by rocky sea bottoms and shorelines in protecting wild post larval marine fish. They work by providing post-larvae and young recruits the opportunity to hide and feed. A double cage system creates a predator-free habitat with adapted food. Therefore the Biohut® system helps to restore the marine ecosystem by protecting YOY from predation, thereby allowing them to reach a "refuge size" before returning to the open ocean.

In 2013, a large scale deployment of this technique was implemented in France. The Biohut® system was installed in several harbors along the French Mediterranean coast and were monitoring by researchers from University of Perpignan. The presentation highlights the importance of protecting and restoring shoreline habitats and presents the first promising ecological benefit assessment of the Biohut® provided by the scientists from the University of Perpignan.

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EMERGING POLICY – POST MARKS FROM THE BLEEDING EDGE

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In 1986, the passage of the Water Resources Development Act (WRDA), specifically Section 1135 and other project modifications in that Act heralded a new authority for the Corps of Engineers to engage in projects for environmental restoration. Since then, every subsequent WRDA has expanded and modified the Corps' authority to participate in projects for environmental restoration. This represented a new "Mission" for the Corps, like navigation and flood control, which has continued to grow and change over time. As with any new mission, the Corps set about establishing policies to govern the implementation of this new authority. Unfortunately, the development of new policies was challenged and delayed by internal conflicts over the scope of this new authority as well as its place in the overall mission of the Corps. Some of these problems continue to plague restoration to this day and will so into the future.

The Comprehensive Everglades Restoration Plan, or CERP, approved by Congress in WRDA 2000, as the first large scale restoration plan for Corps was at the leading/bleeding edge for new policy development. The authorization included a lot of new requirements, opportunities, and challenges for environmental restoration projects that became the "go-by" for future restoration efforts. To implement this project and the new requirements for cost share, crediting, etc., many new policies had to be developed, many of which suffered a very painful process.

The Session discussion focuses on some of the key policy issues from that start up period that involved Federal leadership up to ASA(CW), OMB, CEQ, and even the White House.
New mission/no new funding – OMB said no increase Corps overall budget for new mission.
Compliance with existing project development guidance, Principles and Guidelines formulated before environmental restoration could be project purpose.
Partnerships- though cost share is 50-50, partnership is something less for sponsor.
Cost sharing and crediting for in-kind work, both design and construction and advance work.
What is appropriate future without condition, prerequisites to Federal involvement.
Real estate requirements for restoration, e.g. estate to be acquired and valuation.
Challenges and realities of science based policy.
Other agencies suffered from similar challenges, e.g. Fish and Wildlife had to deal with T&E species and migratory bird issues in a transitional period as well as expanded consultation.

Some Future challenges include: Ecosystem services in project evaluation and justification.
Revision of P&G to incorporate ecosystem restoration planning.
Implication of practical application of Adaptive Management Plans into overall project.
Incorporation of Exotic and Invasive Species impacts into restoration plans.
Ever changing Congressional landscape.
Other experiences? (audience)

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EVERGLADES RESTORATION: THE LEGEND, THE DREAM, THE REALITY

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For over 130 years, the Florida Everglades has suffered an incredible loss of its historic wetlands due to drainage and development with over one half of the original Everglades lost. This has been accompanied by large reductions in the dependent flora and fauna as evidenced by the massive reductions in the once world renown avian rookeries and the near extinction of numerous species.

These concerns and impacts led to the development of the Comprehensive Everglades Restoration Plan, or CERP. This ambitious plan, touted as the salvation for the Everglades, was authorized in 2000. It called for a watershed approach to address water management issues over a 16,000 square mile area inhabited by over 7 million people. The original plan included some 50+ plus projects to be constructed over a 35+ year implementation period at a cost of $7.8 Billion. It would redirect a large portion of the 1.7 billion gallons of water a day currently being flushed out to sea back into the remaining Everglades. The plan would significantly reduce the destruction and loss of the unique habitats in both the coastal estuaries and the central Everglades while re-creating the conditions that allowed those environs to flourish. It was anticipated that the plants and animals so dependent on a wet ecosystem would return in both abundance and diversity while the increase in water would also ensure long term sustainability for agriculture and municipal uses. Even as the long term threat of climate change and sea level rise continues to evolve, the restoration plan was viewed as the single best counter measure for the flat, low lying areas of south Florida.

Now, 13 years later, the plan has grown in cost to over $13 billion and continues to flirt with abandonment as the Federal and State governments grapple with slow progress, rising costs, severe budget challenges, a strained “Partnership”, a long standing Federal lawsuit over clean water, and the continuing development and interpretation of new policies and procedures governing implementation. These problems are being further compounded by the influx and spread of exotic species which threaten to literally alter the environment and make recovery of historic ecological conditions even harder if not impossible.

Despite these challenges, implementation of the plan continues to move forward. Construction is well underway on several key projects. The new streamlined planning approach and the continuing success of other projects like the Kissimmee River restoration, offer hope for the future. This joint presentation will cover the original planning effort to develop CERP, an overview of the plan along with the aspirations of those involved, the startup of program implementation, the challenges of implementation, the successes and the failures, as well as major lessons learned along the way.

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EXOTIC AND INVASIVE VEGETATION CONTROL AND THEIR IMPACTS IN OUR URBAN ECOSYSTEM

Brian Sean Early
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There are many different definitions of invasive species that apply to both flora and fauna. Generally, invasive species are considered to be species that are non-native or non-indigenous to a specific region or habitat and may out compete native species. Most non-native plant species are not invasive, however, a few plant species are successful at establish or naturalizing in an area and spread to new habitats or throughout an eco-region and have deleterious effects on the economy and ecology of a region.

Invasive plants are primarily introduced by anthropogenic action, albeit accidentally or intentionally. Many invasive plants are introduced at home sites by landscaping and spread to adjacent areas in the urban wildland interface. The urban interface and other areas associated with human disturbance are typically the initial sources for invasive plants to establish before moving in the wildlands. Some invasive plants, pose a significant threat to by inhibiting native plant propagation or germination, reducing native species biodiversity, interfering with ecosystem functions like nutrient cycling, degrading water quality, and impeding water flow.

There are many techniques to effectively and efficiently managing negative impacts form invasive plant species. In general developing a community plan to minimize disturbance, constantly monitor for invasive species, and educate the public on conservation initiatives. Early detection and prompt treatment will minimize efforts and costs that come with treating well-established invasive species. Proactive integrated management techniques for both public and private lands, while building creative partnerships with other organizations and agencies are required to successfully manage well established invasive species populations in urban ecosystems and to develop creative solutions and build a more sustainable urban ecosystem.

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ADVANCING THE GULF COAST PRAIRIE LCC SCIENCE STRATEGY

Cynthia K. Edwards
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There are twenty-two Landscape Conservation Cooperatives across the United States that also reach into Canada and Mexico. This network of cooperatives were set up to define, design and deliver landscapes capable of sustaining natural and cultural resources in the face of such threats and stressors as climate change, population growth, and urbanization. This is a cooperative effort between non-governmental organizations, federal and state agencies. The Gulf Coast Prairie Landscape Conservation Cooperative (GCP LCC) provides scientific and technical support, coordination, and communication to the conservation community and fosters cooperative capacity and facilitates the refinement of that purpose through targeted monitoring, evaluation, and adaptation over time.

Within the GCP LCC, the Science Team provides the scientific basis and factual information to advance the mission to sustain, protect, and conserve natural and cultural resources in the Gulf Coast Prairie landscape. A key part of this is developing strategies to direct efforts towards species that the partnership has identified as being key to knowing whether our efforts through Strategic Habitat Conservation are affecting species population targets.

A primary goal of the Science Strategy is to guide and inform LCC science investment decisions going forward to address needs identified by the LCC partnership. By using new and shared resources, the GCP LCC can help partners to (1) organize known and needed information and data; (2) acquire climate, habitat, and species data at relevant scales; (3) measure, model, and monitor effects of stressors on ecological systems, habitats, communities, and species; and, (4) target and facilitate implementation of effective conservation measures to reinforce ecosystem resiliency.

Methods used to achieve this include the identification of habitats across the LCC and defining them in a manner that all partners can agree to – taking into account commonly used terminology at a state or local level. The GCP LCC Science Team has also gone through an extensive process to identify focal species that will be used to direct science priorities and focus efforts to direct implementation of Strategic Habitat Conservation (SHC). The candidate focal species have been broken down into three 'Tiers' – the top one includes six species that intersect twelve of the seventeen identified habitats across the LCC. These will provide the basis for the initial application of SHC: biological planning, conservation design, program delivery, outcome based monitoring, and assumption driven research.

This presentation will outline the cooperative process taken to advance science priorities within the GCP LCC.

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RESTORATION OF A GREAT LAKES COASTAL WETLAND: MEASURING ECOLOGICAL RESPONSE AND FUNCTION

Mike Eggleston *and Kurt P. Kowalski*
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The majority of wetlands along western Lake Erie are isolated from the lake by earthen levees and no longer provide many highly valued functions and services (e.g. fish habitat and improve water quality). The congressionally-funded Great Lakes Restoration Initiative has supported extensive wetland restoration efforts throughout the Great Lakes basin and fueled examination of the effects of hydrologically reconnecting wetland areas to their parent water bodies. Our project at the U.S. Fish and Wildlife Service Ottawa National Wildlife Refuge studied ecosystem response after a water-control structure was constructed and opened to allow the free flow of water between a Lake Erie tributary and a previously hydrologically isolated wetland. This connection allowed the first passage of fish and water into the wetland in over 40 years. For this study, we measured multiple ecosystem parameters both before and twice a month for 3 years after the water-control structure was constructed. The species richness, abundance, and biomass of fish assemblages within the wetland increased after the structure was opened and Lake Erie fish could access newly available nursery, feeding, and spawning habitat. The wetland also acted as a sink for phosphorous in nutrient rich waters draining from the agricultural landscape. These and other results suggest that reconnecting the diked wetland to Lake Erie waters restored several ecosystem services and set the stage for similar restorations started in the region. As all of these restoration projects are completed, new opportunities exist for multi-agency coordination that maximizes ecological benefits on multiple spatial and temporal scales.

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THE NAS GULF RESEARCH PROGRAM: AN OVERVIEW

***Chris Elfring**, Kim Waddell and LeighAnne Olsen*
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In 2010, the *Deepwater Horizon* explosion and fire caused the release of approximately 200 million gallons of crude oil into the Gulf of Mexico. As part of legal settlements with the companies involved, the federal government asked the National Academy of Sciences – an independent, non-profit organization chartered by Congress in 1863 to provide independent, expert, scientific, engineering, and healthcare advice to the nation – to establish a new $500 million, 30-year research program focused on human health, environmental protection, and oil system safety in the Gulf region. The new program, called the Gulf Research Program, is directed to work in three areas: research and development, education and training, and environmental monitoring. Activities will focus on the Gulf of Mexico and other U.S. outer continental shelf regions, but work that transfers knowledge to or from other offshore U.S. or international hydrocarbon-producing regions is allowed under the mandate. The program, which began planning in July 2013, now has had a year to take shape. This presentation introduces the program, summarizes program planning, outlines the program's mission and goals, and describes first-year activities. It will highlight the program's intended emphasis on facilitating innovation, education, collaboration, and cross-disciplinary work.

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ENGINEERING AND CONSTRUCTION OF SOUTHERN CALIFORNIA LAGOONS WITH EMPHASIS ON SAN DIEGUITO LAGOON

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The San Dieguito Lagoon was once the largest coastal lagoon in San Diego, California. At one time, it extended over 1,000 acres. Historical records indicate that the lagoon mouth was open most of the time. However, approximately 50% of the San Dieguito lagoon was filled for construction, and by 1940 the mouth of the lagoon was closed near year round.

The San Dieguito Wetland Restoration Project began in the early 1990s as mitigation for impacts of the San Onofre Nuclear Generating Station (SONGS) cooling system's operation on the marine environment, which included loss of fish larvae and immature fish. Several wetland designs were given serious consideration: 1) creation of a maximum tidal basin, 2) creation of a maximum intertidal zone, 3) reduction of berms, and 4) creation of a mixed habitat. After careful consideration, the mixed habitat approach was selected. The mixed habitat design increased the size of the lagoon by adding more than 115 acres (net) of wetlands.

There were many challenges associated with the San Dieugito Wetland Restoration Project. Approximately 2.3 million cubic yards of material had to be dredged in order to create the tidal basins, channels, and permanent lagoon inlet. The land had to be obtained from many different owners, there were various competing interests, and regulatory hurdles. The need to minimize potential impacts on adjacent beaches was of particular importance since there was concern that opening of the inlet would create beach erosion at adjacent beaches. It had to be proven that the restored lagoon would not increase beach erosion.

All beach quality sand that was not used to create the wetland and nesting sites was deposited on the beach. It was also important to keep the sediment supply from the San Dieguito River to the lagoon intact in order to increase sand deposits on the beach from the lagoon. Periodic dredging was selected as the maintenance approach to keep the inlet open. Other options such as the construction of a jetty to keep the lagoon inlet open were eliminated due to potential for beach erosion / net sand loss.

The newly constructed wetland serves as a thriving fish hatchery, a refuge for migratory waterfowl, and an open space for recreational activity. This is the first project of its kind in San Diego County.

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INNOVATIVE WAYS OF CONSERVATION

Terrell Erickson
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Conservation planning and application on private lands takes science and policy innovation, partnerships, and boots on the ground. The Natural Resources Conservation Service employs multiple scales and methods to stimulate these efforts across the U.S. In this presentation, I describe some recent examples of the diversity of our efforts, focusing on (1) new or improved science practices, (2) partnerships that make a difference and (3) new evaluation mechanisms that provide clues for adaptive management in our conservation work.

One of approximately 170 of NRCS' conservation practices that can be used in a system to conserve and protect air, soil and water quality is our nutrient management planning practice standard, code 590. The 590 is a planning tool both for regular agricultural operations applying nutrients and for developing Comprehensive Nutrient Management Plans for confined animal operations that use their manure and wastewater to grow crops. We have recently revised the 590 to incorporate innovative approaches, including adaptive management. Adaptive management takes data (measurements and observations) and evaluates success based on scientific principles and local experience. This iterative and interactive learning process looks for win-win opportunities, so that growers adopt practices that make sense locally for increasing profits and for conserving natural resources at the same time on farm and beyond.

NRCS's innovative use of partnerships includes "Conservation Partners" with the National Fish and Wildlife Foundation and other regional and initiative specific organizations, including industry, conservation entities, and conservation districts. It provides competitive grants that support field conservation specialists working with NRCS field staff to optimize aquatic and terrestrial habitat conservation on private lands. The Upper Mississippi River Basin is a priority area where Conservation Partners are focusing. A second example is the agency's intrinsic ability to work with partners at the field level rapidly, as demonstrated by the Migratory Bird Conservation Initiative, which occurred directly after Deep Water Horizon, resulting in restoration of over 471,000 acres of shallow water habitat for migratory birds within less than four months.

In FY 2013, NRCS introduced two new Edge-of-Field Water Quality Monitoring activity platforms for individual monitoring projects. Results will provide a) science-based evidence of conservation benefits, b) data for improvement of predictive water quality models, and c) a basis for on-farm nutrient application adaptive management. In 2013, and again in 2014, these activities are being made available in watersheds in designated Landscape Conservation Initiative areas, including the 12-digit watersheds funded in active Mississippi River Basin Restoration Initiative Cooperative Conservation Partnership Initiative (CCPI) projects.

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SPEAK UP! OVERVIEW OF CURRENT STATE OF KNOWLEDGE AND PRACTICE IN ECOLOGICAL RESTORATION

Panel Organizer: ***Aida Farag***[1]

Session Panelists: Cheryl Ulrich, David Ross[2]*, Judy Haner*[3]*, and Dale Gawlik*[4]

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[2]Natural Resource Damage Assessment, DOI
[3]The Nature Conservancy
[4]Florida Atlantic University

The Society for Ecological Restoration (SER) is developing a new publication that frames the current state of knowledge and practice of ecological restoration. Its goal is to introduce a relatively uninformed global audience to the field of ecological restoration, its objectives, scope, relevance, history, leading approaches, current challenges, and possible future directions.

Early phases of this work were aimed at soliciting a diverse range of perspectives and establishing consensus on key issues related to, for example, global climate change, novel ecosystems, resilience, re-establishment of traditional Aboriginal relationships with nature, socio-economic dimensions of restoration, and attributes of restored ecosystems.

This presentation will provide an overview of the draft document. Areas in which audience members' recommendations would be particularly useful (e.g., identification of relevant case studies) will be identified. Audience members will be provided with details regarding how to provide such recommendations.

The presentation will be followed by a panel discussion. Panelists, guided by a moderator, will raise questions for the audience and each other to consider. Answers will help to guide decisions as to the format and content of the final product, in order to help ensure that it meets the needs of its intended users. Audience members will be encouraged to provide their own perspectives on the work done to date and to suggest inspiring case examples, photographs, and other material that might be considered for inclusion in the final product. Be prepared for debate and discussion around issues such as the role of ecological restoration in addressing climate change, novel ecosystems, socio-economic issues, etc.

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REMOVING BARRIERS TO TIDAL HYDROLOGY AT MARSHES IN MAGNOLIA BEACH AND INDIANOLA, TEXAS

***R.A. Feagin*[1]*, T. Huff, A. Hinson, A. Biedenharn and J. Moya*[2]**
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A large expanse of salt marsh wetlands is disintegrating from Magnolia Beach to Indianola in Calhoun County. The wetlands appear to be suffering due to a lack of tidal flow, due to multiple hydrological restrictions. Large areas of vegetation are dying, fish kills have occurred, endangered Whooping Cranes could be negatively affected, properties are flooding, recreational access has been inhibited, and citizens are concerned.

A long-term plan being implemented by several collaborators seeks to first remove barriers to flow at the "Magnolia Inlet" and "Fish Pass" barriers, and then remove the nested "Zimmerman Road" barrier. To identify the extent of the problem and monitor restoration progress as barriers are removed, we placed water level and salinity gauges throughout the marsh complex. The records showed that much of the marsh complex is impounded and that the water is hypersaline, primarily due to the Magnolia Inlet barrier. We classified aerial photography for several dates between 1972 and 2012, and found that approximately 45,830 linear feet of shoreline is eroding and 473 acres of marsh have already been lost, largely since 1996. Local fisherfolk accounts suggest that the blockage at the inlet began around this same time period, and in concert with the other two pre-existing barriers, resulted in the disintegration of the ecosystem. We also recorded densities of nekton and birds, and the health of vegetation on either side of each barrier. Vegetation is dominated by *Spartina alterniflora* and *Batis maritima*, depending on location. Nekton caught by drop samplers and seine nets include shrimp, fish, crabs, and insects. Surveys suggest that birds are using the barriers to catch trapped nekton. As we remove the barriers, we are also monitoring the changes in the water level, salinity, flora, and fauna. This project highlights the potential of restoring tidal hydrology by removing barriers as a cost-effective manner to restore large areas relatively quickly.

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STRATEGIES FOR IMPLEMENTING REGIONAL SEDIMENT MANAGEMENT: USING A COLLABORATIVE APPROACH TO IMPLEMENTING RSM PRINCIPLES IN ALABAMA

Carl Ferraro

Alabama Department of Conservation and Natural Resources, State Lands Division-Coastal Section, Spanish Fort, Alabama, USA

In order to advance the implementation of Regional Sediment Management (RSM) principles, the use of a collaborative approach is crucial. Through a long standing partnership between state, local, federal and NGO partners, Alabama has used just such an approach to successfully implement an RSM program. In the late 1990's, the idea of RSM was in its infancy. The U.S. Army Corps of Engineers Mobile District (Mobile District) was chosen as one of the initial pilot sites for implementation of the RSM approach. At that time, the Alabama RSM Working Group was formed. This group included various state, local and federal resource agencies, which worked together to implement a number of pilot projects, mainly at the Perdido Pass Navigation Project. These project required the cooperation of numerous partners and had varying degrees of success.

Following these initial efforts, the Alabama RSM Working Group continued to collaborate and to pursue additional RSM related projects. These mainly concentrated on sediment bypassing at tidal inlets, including additional projects at Perdido Pass, the implementation of the Sand Islands Beneficial Use Area and small scale demonstration projects on the east end of Dauphin Island.

Most recently, the group reformed into the Mobile Harbor Beneficial Use Group (MHBUG), with efforts concentrating on the beneficial use of finer grain sediments along the upper reaches of the Mobile Harbor Navigation Project. Through the use of a collaborative approach, the MHBUG has been able to implement two large scale beneficial use projects: the Brookley Hole Beneficial Use Project and the Mobile Harbor Thin Layer Pilot Project. By using a collaborative approach, the MHBUG was able to very quickly plan, permit and implement these projects, resulting in the beneficial use of over 9 million cubic yards of fine grain sediments. Monitoring of these project continue, with clear water quality benefits being realized at the Brookley Hole project site.

Additionally the MHBUG is planning a very large scale beneficial use/marsh creation site in the upper Mobile Bay. This effort is in the design, planning and environmental investigation phase and is proceeding via the same collaborative process used so successfully in past efforts in coastal Alabama.

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CHALLENGES AND REWARDS OF TRANSDISCIPLINARY COLLABORATION TO SUSTAIN ECOSYSTEM SERVICES

***Christine Feurt*[1]*, Robert Johnston*[2]*, Verna DeLauer*[2] *and Kristin Wilson*[3]**

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This research examines the barriers to transdisciplinary research in the context of a national system of marine protected areas, the National Estuarine Research Reserve System (NERRS). The Sustaining Coastal Landscapes and Community Benefits project based at the Wells, Maine NERR, developed and tested approaches to valuing ecosystem services associated with riparian buffers as a model for collaborative research that increases the impact of science on decision-making and policy. Ecological, economic, mental modeling methods and a communication audit were integrated with a multi-stakeholder engagement process to model a new approach to research in the NERRS. The NERRS is uniquely positioned to test, implement and evaluate the application of transdisciplinary research that integrates quantitative information on ecosystem service values and tradeoffs at a scale appropriate to improve decision-making. Although the sensitivity of ecosystem services to changes in riparian land use is unquestioned, the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This model of collaborative research was developed to address these challenges.

This research project was conducted collaboratively with a diverse group of local stakeholders whose management objectives for conservation and restoration include sustaining riparian ecosystem services. This stakeholder group will use the results of this research to improve messages and dialogues about trade-offs to policy makers and constituent groups. The local, state and federal agencies, watershed groups and land trusts in this stakeholder group approach their work through a predominantly biophysical lens with incomplete understanding of the theories, methodologies and frameworks applied by ecological economists. This research opened that lens to include an economic perspective.

At a national scale this research builds upon the ecological and communication strengths of the NERRS and addresses gaps in the application and integration of socio-economic approaches to improve the impact of NERRS science on decision-making for riparian and wetland area management, including policy processes and decisions influencing land use, habitat and nonpoint source pollution. Challenges and benefits associated with integrating economic frameworks and methodologies within the dominantly ecological perspectives of the NERRS and local stakeholders will be the focus of this presentation.

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INTERDISCIPLINARY PANEL & AUDIENCE ENGAGEMENT - BENEFITS AND BARRIERS OF ECOSYSTEM SERVICE VALUATION FOR ECOSYSTEM RESTORATION PRACTICE AND POLICY

Christine Feurt
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Riparian buffers and wetlands are a nexus for complex land use challenges where tradeoffs for ecosystem services must be evaluated. Ecological, economic, mental modeling methods and a communication audit were integrated with a multi-stakeholder engagement process to model a new approach to research in the National Estuarine Research Reserve System (NERRS). Although the sensitivity of ecosystem services to changes in riparian land use is unquestioned, the quantification of associated spatially-explicit human benefits and tradeoffs, as well as the use of resulting information to guide policy, is often hindered by methodological gaps between economic approaches though which ecosystem services are defined and valued and ecological paradigms through which ecosystem processes are modeled. This model of collaborative research was developed to address these challenges. At a national scale this research builds upon the ecological and communication strengths of the NERRS and addresses gaps in the application and integration of socio-economic approaches to improve the impact of NERRS science on decision-making for riparian and wetland area management, including policy processes and decisions influencing land use, habitat and nonpoint source pollution. Challenges associated with integrating economic frameworks and methodologies within the dominantly ecological perspectives of the NERRS and local stakeholders will be the focus of this session from the perspectives of each team member engaged in the four year project.

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THE MOBILE-TENSAW DELTA: A NEW CONSERVATION MATRIX FOR ONE NORTH AMERICA'S MOST DIVERSE LANDSCAPES

William A. Finch
Earthword Services, Mobile, AL, USA

The Mobile-Tensaw Delta and its surroundings represent one of the most species rich environments in North America. The cornerstone is some 350,000 acres of one of the best-preserved deltaic flood plains in the continental U.S., connecting one of the temperate world's most biologically diverse freshwater basins, the Mobile Basin, with the continent's most diverse large marine ecosystem, the Gulf of Mexico. On the uplands surrounding it are hyperdiverse longleaf pine forests, often supporting 30 to 50 species of plants per square meter, and steep bluff and ravine forests supporting unusual broadleaf diversity, with more than two dozen species of oaks and seven species of magnolias, for example. This area is also a North American hot spot for endemism and is a global hotspot for turtle diversity.

The unique features of this area have been too long overlooked both locally and nationally, and in recent years, there has been a renewed effort to dramatically ramp up conservation effort there. A significant portion, some 125,000 acres, has been brought into conservation ownership or management. But much of that effort has focused on the floodplain and has missed the much more diverse and accessible areas outside of the frequently flooded zones. There is now recognition that this world-class treasure will need to be conserved in a larger landscape context.

One of the conservation opportunities now being sought is some type of partnership with the National Park Service. Park Service designation could elevate the profile and conservation importance of the area, as well as providing additional opportunities for federal support. Public misperceptions about how the Park Service operates can impede this process. Park Service conservation efforts for the 21st Century require a suite of conservation tools, ranging from easements and incentives on privately held lands to outright fee simple conservation purchases. As we develop plans for conservation of the Mobile-Tensaw Delta and its surroundings, we are devoting a major effort to managing people's expectations about what a park unit might encompass. In many cases, the public's concepts of a traditional contiguous and expansive park unit can result in disappointment that the park unit proposals aren't larger, and abject fear that some day it will be. If the public had a better understanding of the Park Service's goals for an ownership and management matrix, it's likely to diffuse a significant potion of the opposition to the development of a park unit concept.

We'll be discussing the variety of tools we're exploring to develop a larger conservation context and to complement a conservation study by the National Park Service. And we'll examine how we will be communicating these multiple options to landowners, key stakeholders, and the broader public.

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CONDUCTING AN EFFECTS ANALYSIS FOR SYSTEM-WIDE EVALUATION OF ENDANGERED SPECIES STATUS ON THE MISSOURI RIVER

Craig Fischenich[1] *and Kate Buenau*[2]
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The Missouri River Recovery Program has undertaken an Effects Analysis (EA) to evaluate recovery actions for three federally listed species on the Missouri River Mainstem System (MRMS). Pallid sturgeon (*Scaphirhynchus albus*) is an endangered, benthic fish endemic to the turbid Missouri River and the lower portions of larger tributaries. Least terns (*Sternula antillarum*) and piping plovers (*Charadrius melodus*) nest on emergent sandbars and reservoir shorelines on the MRMS. Habitat for all three species has been strongly affected by the construction and operation of reservoirs on the MRMS and by the construction of navigation, bank stabilization, and flood control measures on the river. A Biological Opinion (BiOp) issued by the U.S. Fish and Wildlife Service (USFWS) identified reasonable and prudent alternatives (RPAs) to avoid jeopardy to these Missouri River populations (USFWS 2000, 2003).

An effects analysis (EA) has been undertaken to assess the effect of current river management on the species' populations and quantify the effectiveness of current and potential management actions in terms of species demographics. The EA involves: 1) development of a set of conceptual ecological models relating stressors, ecological responses and species performance and the construction of accompanying hypotheses about the effects of management actions on the species demographics, 2) collection, analysis and synthesis of literature, existing data, and numerical models, 3) development of decision-relevant numerical models for physical habitat and species populations, 4) model sensitivity analysis, calibration and validation, and application to assess proposed management measures and alternatives, 5) evidence based assessment of hypotheses, and 6) documentation of methods and results of the analysis.

This EA differs from the more conventional effects analysis in that a BiOp already exists and the Reasonably Prudent Alternatives (RPAs) are being implemented. The BiOp stipulated the inclusion of an adaptive management (AM) program. The EA will support AM decisions in the long-term and the near-term assessment of management alternatives to determine which is most efficient in avoiding jeopardy. A decision-relevant modeling framework is required to test hypotheses and assess management actions, resulting habitat transformations, and the effects on species demographics. We have concurrently developed a set of population models and supporting hydrological, hydraulic, and geomorphological models to meet this need. Key to the model framework has been the ability to directly address uncertainty, such that its impact on decisions can be fully understood and used to guide future monitoring and research as part of the adaptive management process. Communication among the model development teams, the managers, stakeholders, and an independent science advisory panel reviewing the effort was critical.

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STRUCTURED DECISION MAKING, ADAPTIVE MANAGEMENT AND MISSOURI RIVER RECOVERY IMPLEMENTATION COMMITTEE: A PATH FORWARD

Craig Fleming
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The U.S. Corps of Engineers Missouri River Recovery Program (MRRP) has embraced the concept of Adaptive Management (AM) and has been developing and using AM as a means of improving our overall MRRP effectiveness by including stakeholders, structuring our information, models and process to avoid jeopardy to the listed species on the Missouri River. Since adopting this strategy we have established a broad based stakeholder group (Missouri River Recovery Implementation Committee) and Independent Science Advisory Panel and a process for their inclusion in developing and implementing the Adaptive Management process on the Missouri River

Structured Decision Making (SDM) was used to develop individual Adaptive Management strategies of actions we have been implementing. The structure and modeling components have been helpful in garnering a broader appreciation for AM process and tools. Scaling up from individual AM strategies to a system wide integrated AM strategy has presented multiple challenges both internally and with our stakeholder group. These challenges: policy and values conflict, governance and transparency issues, effectiveness of existing actions, integration of flow and mechanical actions, and meaningful engagement with stakeholders, have presented us with new opportunities for growth. The Independent Science Advisory Panel reviewed components of our work and recommended an integrated AM approach using SDM preceded by an Effects Analysis to address the technical deficiencies. Our engagement process with MRRIC has included intense engagements with intensive modeling to address stakeholder interests. Our internal team has established a vertical team and SDM process to continue to address these challenges and achieve species objectives through development of an integrated Adaptive Management Plan.

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NATIONAL PARK SERVICE RESTORATION IN GULF OF MEXICO COASTAL PARKS

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The National Park Service has 9 park units in coastal Gulf of Mexico. These account for nearly 2 million acres of water bottoms, baldcypress swamp, marsh, barrier island beach and dune, bottom land hardwood forest and mangrove swamp. Potential restoration of coastal habitats is being planned under the early restoration planning from the BP oil spill, the RESTORE Act and recent hurricanes. Potential restoration activities include SAV bed restoration at Jean Lafitte National Historic Park and Preserve (JELA) and Gulf Islands National Seashore (GUIS), barrier island beach and dune restoration at GUIS, restoring hydrology in the Everglades (EVER), controlled prescribed burns, and shoreline restoration in various Gulf coast parks. Plants and animals benefiting from restoration projects could include bay scallops, beach mice, sea turtles, submerged aquatic vegetation such as seagrasses, longleaf pine communities, and all of the common swamp, bottomland and marsh species found in the parks throughout the Gulf of Mexico.

Specific types of restoration could include, and certainly are not limited to canal backfilling of old used canals. In Louisiana, there are opportunities to restore canals and lower spoilbanks back to the level of emergent wetlands or shallow water habitat (JELA). For beach mice, measures are identified to promote habitat enhancement and general protection by: 1) Facilitating public access in an environmentally responsible manner; 2) Revegetation of select areas to promote dune formation and habitat connectivity; and, 3) dedicated monitoring to document relative abundance and distribution of the species (GUIS). Bay scallop restoration can be accomplished by contracting for four spawning batches of scallops to be delivered in each of the three years of this project. This multi-layered stocking technique has resulted in several successful scallop reintroductions by the state of Florida in the past to reestablish scallop populations(GUIS). Longleaf pine restoration involves completing prescribed controlled burns over the course of a 5 year period in both the Park's Florida and Mississippi Districts (GUIS). New introductory and follow-up cyclic maintenance burns would be conducted over a 5-year period. Sea turtle restoration will ensure hatching events are closely monitored and will ensure hatchlings enter the Gulf of Mexico and do not suffer mortality as they wander disoriented in the interior of the islands (GUIS and Padre Island National Seashore-PAIS). The shoreline protection project, which will be conducted in the soft coastal sediments of Louisiana, (JELA) will involve using stone laid directly on the natural slope of the shoreline, or, where indentations occur, just offshore. It is these indentations that will subsequently be filled with dredged material to restore wetlands.

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APPROACHES TO EVIDENCE-BASED EVALUATION OF PUGET SOUND ECOSYSTEM RECOVERY

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The Action Agenda is a road map that lays out the work needed to recover Puget Sound by 2020 and is the Comprehensive Conservation and Management Plan for the National Estuary Program under the Clean Water Act. The Puget Sound Partnership (PSP) leads a collaborative effort by state and federal agencies, tribal governments, local governments, business and environmental groups and other interested parties to identify and implement the most important actions to recover Puget Sound. The Action Agenda is updated approximately every two years, and the most recent version identified three region-wide priorities: prevent pollution from urban stormwater runoff; protect and restore habitat, particularly habitat critical for salmon recovery; and recover shellfish beds.

The Puget Sound Ecosystem Monitoring Program (PSEMP), a consortium of regional monitoring experts, tracks the cumulative impact of efforts to recover Puget Sound. In 2013, PSP and PSEMP began to emphasize measurements of the impact of actions on ecosystem components, because information about the effectiveness of management and restoration actions drives our adaptive management cycle. This presentation shows how we compared the effectiveness of various actions across Puget Sound using statistical meta-analysis. We calculated change statistics from measures of ecosystem condition before and after management actions. Change statistics are unitless and can be used to compare the relative effectiveness of diverse actions, such as water quality improvement projects, bans on toxics, and habitat restoration efforts. We compared actions at multiple scales for a variety of response variables across the Puget Sound watershed. Our goal is to roll up measures from the site or project scale to support decisions at the regional scale regarding which recovery actions to prioritize in the Action Agenda and how to best allocate funding.

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CITYWIDE ECOLOGICAL ASSESSMENT: A TOOL FOR PROIRITIZING MANAGEMENT IN NYC

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The Natural Areas Conservancy (NAC) is a not for profit organization working in partnership with the New York City Department of Parks and Recreation (Parks) tasked with expanding and diversifying the protection, management, and restoration of 10,000 acres of forests, wetlands and grasslands in New York City (NYC). In 2013, the NAC initiated the first-ever citywide ecological assessment of NYC's natural areas and the creation and implementation of science-based decision making and management tools to guide future natural resource conservation efforts. The citywide ecological assessment is designed to create a paradigm shift from an opportunistic to a data-driven decision making process. The assessment will lead to development of quantifiable metrics that will direct management and protection of natural areas based on scientific rationale. Ranking and evaluating health metrics will create an analytic tool created to demonstrate effective management strategies.

Data is collected and analyzed using a replicable, statistically significant, and adaptive methodology to be shared with public agencies, partner organizations and regional landowners to inform the protection, restoration, acquisition, and management priorities of Park's natural areas.

The ecological assessment:
Identifies ecological "reference ranges" for healthy NYC habitats. Defining functioning systems provides a benchmark for natural areas and provides managers and planners with an understanding of what is achievable and sustainable.
Creates indices of health to monitor the effectiveness of restoration and management over time.
Provides a mechanism for selecting projects based on ecological value, sustainability and cost.
Creates an approach to conservation, restoration and management for urban natural areas.
Uses data and research to strengthen public policy and programming that support conservation.
Strengthens conservation partnerships and infuses data-driven decision making into planning and management.

Within natural areas, specific data defined for collection is based on system types and indicators of health and is customized for communities based on current ecological understanding and partner input. Methodology was developed by NAC with an advisory team of partners. The fieldwork component of the assessment is funded and planned to include a second 2014 field season in which all natural area parkland managed by NYC Parks will be assessed.

The short and long term goals of the ecological assessment's comprehensive, integrated approach serve to promote the mission of the NAC and Parks by providing tools for the effective stewardship of the City's natural areas to create a healthy, safe, and resilient New York City.

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TECHNOLOGICAL ADVANCES IN SEA TURTLE RESTORATION: THE DWH NRDA PROGRAM AND COASTAL LIGHTING

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Loggerhead sea turtles (*Caretta caretta*) are listed as federally-threatened throughout their range. Artificial lighting along northern Gulf Coast nesting beaches negatively impacts loggerhead nesting and hatchling behaviors, including deterring sea turtles from utilizing potential nesting beaches, affecting migration to and from beaches, and disorienting hatchlings. Addressing light pollution in these areas can directly benefit loggerheads during the breeding season.

Northern Gulf Coast beaches impacted by the Deepwater Horizon (DWH) spill provide important nesting habitat for loggerheads. As part of the Natural Resource Damage Assessment and Restoration process, the DWH natural resource trustees are implementing restoration to partially compensate the public for injuries to sea turtles by improving negative impacts from artificial lighting along loggerhead nesting beaches. The U.S. Fish and Wildlife Service is collaborating with Gulf Power, Escambia County, Santa Rosa Island Authority, and other stakeholders on Santa Rosa Island, Florida to replace historic lighting with "sea turtle-friendly" lights on nesting beaches, a common practice in coastal areas . These lights produce wave lengths in a portion of the spectrum that reduce the distraction to sea turtles, but still meet the original purpose of illuminating dark areas for the benefit of people. This compromise historically came at a high economic cost. However, an emerging industry of commercial light emitting diodes (LED's) which produce sea turtle-friendly amber wavelengths but continue to adequately illuminate public use areas, making sea turtle-friendly lights more economically feasible. These bulbs are extremely energy efficient, and are expected to last for more than 15 years—significantly reducing replacement and maintenance costs. All of these factors combine to create a great incentive for bulb owners, power companies, and natural resource managers to use these bulbs and associated fixtures near nesting beaches. Manufacturers of these lights are also beginning to take advantage of the new economic and regulatory standard crossroad in getting their bulbs and fixtures certified by the state of Florida to meet applicable regulatory requirements.

Replacing historic lighting with turtle-friendly amber LED's and associated fixtures at large scales requires significant startup costs. While the long-term savings dwarf these initial costs, replacement can be prohibitive for some projects. Funding such as that provided through the DWH NRDA program provides an opportunity to stimulate the regular use of these products. We discuss lessons learned while planning and implementing such a project and describe how it can be a showcase project for the capability of the new amber LED's.

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PREDICTIVE MODELS TO SUPPORT EVALUATION AND SELECTION OF RESTORATION AND PROTECTION ALTERNATIVES

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Predictive modeling tools are an integral part of any large-scale and long-term planning effort. Louisiana has a long history of planning using predictive models, such as the Coastal Louisiana Ecosystem Assessment and Restoration (CLEAR) effort, the Louisiana Coastal Protection and Restoration (LaCPR) Technical Report, and the 2007 Coastal Master Plan, in addition to individual project and regional modeling. But after each of these initiatives, the tools and models used in the decision-making process were discontinued due to a lack of dedicated funding. The Coastal Protection and Restoration Authority (CPRA), upon embarking on the 2012 Coastal Master Plan effort, made the commitment to provide dedicated funding to develop, maintain and improve a suite of modeling tools needed to make decisions on the master plan, individual projects and system operations well into the future.

Understanding the management needs and questions is important to developing the appropriate predictive capabilities. The 2012 Coastal Master Plan was developed to understand which projects, out of thousands previously proposed, would provide the greatest benefit coastwide considering important resource constraints such as funding, water and sediment. The 2017 Coastal Master Plan is being developed to understand project synergies and conflicts and how regional project implementation strategies affect outcomes. Both efforts will provide predictions of future with and future without action under various scenarios.

The master plan models are designed to be lower resolution, planning level models that can efficiently (time and cost) run a large number of alternatives. The modeling tools are being modified and improved for the 2017 Coastal Master Plan by incorporating additional processes, improving the resolution, conducting uncertainty analysis, increasing the time step between modules, providing better predictive tools for ecosystem outcomes, and integrating the models into one platform. Throughout the development of the Model Improvement Plan attention was given to how an improvement would affect the cost and time required to run the model.

The spatial and temporal scale of the master plan models are designed to provide useful information on a coast-wide or basin-wide level, but will not provide the type of detailed site-specific information needed to engineer, construct or operate a project. For this information, CPRA has committed to the development, maintenance and improvement of predictive models to assist with the permitting, operation and management of projects. In coordination with U.S. Army Corps of Engineers, CPRA is developing a whole suite of tools to evaluate the hydrodynamics and morphology of the Mississippi River. CPRA is also developing a multi-dimensional model that incorporates hydrodynamics, including nutrients, and morphology to predict basin-side effects of projects.

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COLORADO RIVER BASIN MANAGEMENT – SUPPLY AND DEMAND

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The Colorado River is the lifeblood of the southwestern United States. Stretching from the highest peaks of the Rocky Mountains to the Gulf of California, it travels over 1,400 miles across a watershed that includes seven states within the United States and two states in northern Mexico. Nearly 40 million Americans rely on the Colorado River system for drinking water and to support livelihoods ranging from farming to recreation. Integrated river basin management is vital in emphasizing and protecting the economic, cultural, and ecologic significance of this river.

Spanning parts of the seven states of Arizona, California, Colorado, New Mexico, Nevada, Utah, and Wyoming, the Colorado River Basin is one of the most critical sources of water in the western United States. The River and its tributaries provide water to nearly 40 million people for municipal use, supply water to irrigate nearly 5.5 million acres of land, and are the lifeblood for at least twenty-two federally recognized tribes, seven National Wildlife Refuges, four National Recreation Areas, and eleven National Parks. Hydropower facilities along the Colorado River provide more than 4,200 megawatts of electrical generating capacity, helping to meet the power needs of the western United States and offset the use of fossil fuels.

Impacts from floods and droughts have elevated the necessity for water planning and management to new levels, requiring expanded science, collaboration, and forward thinking. Just as we benefit from the planning and works of prior generations, it is our obligation to use the best information available to us to prepare for the water management challenges ahead.

Findings indicate that in the absence of timely action to ensure sustainability, there exists a strong potential for significant imbalances between water supply and demand in the coming decades. As the Colorado River Basin copes with yet another year in an unprecedented drought extending back to 1999, the challenges of the integrated management task at hand are more real than ever.

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MOISTURE REGIME GOVERNS WHAT DRIVES REINVASION DURING RESTORATION; EVIDENCE OF CRYPTIC OPPORTUNITIES FOR EASY RESTORATION

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Reinvasion pressure is the rate of new exotic recruitment after removing mature conspecifics, and it influences outcomes and costs of restoration and invasive species control. Reinvasion pressure varies broadly among restorations of habitats dominated by the same species, but we poorly understand why. Our 'outgrow the stress' hypothesis holds that ontogenetic niche expansions allow plants to colonize typically unsuitable habitats during temporarily favorable conditions if windows persist long enough for colonists' niches to expand sufficiently. Over time, long-lived invaders that exhibit niche expansions can dominate both favorable and unfavorable habitats, thereby masking differences in recruitment success that produce broad variation in reinvasion pressure observed during restoration. Thus we hypothesize reinvasion pressure is determined by availability of propagules and favorable abiotic conditions, and moderated by factors that influence growth during abiotic windows (e.g. biotic interactions and resource availability).

To test our 'outgrow the stress' hypothesis we manipulated soil moisture and native and exotic seed densities within eleven experimental restoration sites in southeast Texas. Sites represent a moisture gradient and each was initially dominated by invasive *Triadica sebifera* (Chinese tallow tree). We emphasized soil moisture because water regime governs *Triadica* distribution, and *Triadica*'s moisture niche expands rapidly after germination.

As predicted, propagule availability was the strongest predictor of reinvasion pressure in sites with favorable moisture regimes, but moisture treatment was the overriding factor in water-stressed sites. Increased native competition reduced *Triadica* growth generally and decreased *Triadica* survival in some stressful sites. Despite initial *Triadica* dominance, minimal post-removal management was required for successful restoration in five of eleven sites. Native plant communities varied widely among sites. Seed addition increased some functional groups in some sites, and moisture treatments had mixed effects. Native performance was negatively correlated with *Triadica* prevalence and treatments that promoted *Triadica* performance. Our results support the "outgrow the stress" hypothesis and validate many of its predictions. This study substantiates the merit of niche-based models of reinvasion pressure that consider fluctuations in both abiotic conditions and abiotic tolerances of invaders. Reinvasion models can improve restoration efficacy and efficiency by informing management strategies and site selection.

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AN OVERVIEW OF THE AMERICA'S LONGLEAF RESTORATON INITIATIVE

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Longleaf pine forests once covered an estimated 90 million acres from Virginia to Texas in the southeastern United States. These fire adapted ecosystems provide important habitat to a large number of native plant and animal species, including several threatened and endangered species. Longleaf pine forests are better adapted to withstand catastrophic wildfire, southern pine beetle infestations, and damage from hurricanes and these forests are important economically to the southeast. By the year 2000, the longleaf pine forest type had declined to under 3 million acres.

During the 1980s and 1990s increased efforts to conserve longleaf pine began and in 2009 the Range-wide Conservation Plan for Longleaf Pine was released that provided a framework and a long-term restoration goal of increasing longleaf pine forests to 8 million acres. Since the release of the Conservation Plan, a strong partnership of agencies and organizations has coalesced around longleaf conservation in an effort referred to as the America's Longleaf Restoration Initiative (ALRI).

In 2011, conservation leaders from across the southeast created the Longleaf Partnership Council (Council) to promote effective communication and collaboration between the many involved public and private partners. The Council and its members provide the needed leadership to advance the range-wide restoration goals. A network of 16 local implementation teams has formed across the range to increase collaboration within the recognized Significant Geographic Areas (SGAs) for longleaf pine. These teams are providing additional education and outreach to private landowners and sharing of member's resources, resulting in increased longleaf pine establishment and prescribed burning. The work of the public and private partners that began in earnest in the 1980s, and continuing today, has halted the century-long decline of longleaf pine forests and reversed the trend, resulting in an 8% increase in longleaf pine since 2000.

The Council released the 2013 Range-wide Accomplishment Report. The collective work of the many involved partners resulted in 1.4 million acres of on-the-ground restoration work accomplished, that included 1.1 million acres of critical prescribed burning. Approximately 75% of this worked occurred within the recognized SGAs. There were also significant accomplishments in the protection of important longleaf tracts through public land acquisition and private easement programs.

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INTEGRATED APPROACHES TO ACHIEVING ENVIRONMENTAL GOALS IN NORWAY'S FJORDS

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In the early 2000s, Norway established goals for a comprehensive policy on the marine environment for the purpose of promoting sustainable environmental development. Justification for the policy was twofold: to support the needs of commercial activities that rely on aquatic resources and to achieve Norway's obligation to comply with international regulations under the European Water Framework Directive. Key to this goal was improving the environmental status in fjords and harbor areas that have been historically impacted by both diffuse and point sources. Although these discharges have been significantly reduced in recent years, contaminant flux from localized and diffuse polluted sediments may still represent potential impacts to human health and the environment.

The Norwegian Environment Agency (NEA, formerly the Norwegian Climate and Pollution Agency) has identified 17 priority areas where action plans have been developed for the remediation and restoration of sediments within the fjords on a large-scale basis. During development of these action plans, several scientific studies and pilot projects were performed to better understand the distribution and migration of pollutants within the fjords and the efficacy of remedial approaches that may be applied. One of the more widely studied fjords is the Grenlandsfjord in southern Norway. Modelling showed that extensive areas would require remediation if a local goal of reducing dioxin concentrations in fish should be reached. To that end, pilot studies were performed to assess the efficacy of placing thin-layer aggregate and reactive caps to reduce the bioavailability of toxins. Experiments indicated that such remedial approaches could be effective; however, implementation on a fjord scale would be extremely expensive and the potential to negatively affect benthic fauna and flora was identified.

In addition to fjord-scale focused studies, NEA has also investigated the contributions of more localized sources of pollution associated with ports and industrial facilities. However, although remediation of contained areas with high pollutant levels may be required from a source control perspective, in some cases the contaminant flux from such sites was found to be negligible in comparison to allowable discharges from nearby permitted sources and from the diffuse pollutants already deposited with in the fjord. Therefore, it is apparent that fjord-based remedies are necessary to reaching the overall (local and regional) environmental goals. Several challenges must be overcome including implementing good upland source controls, identifying a solvent responsible party (under "the polluter pays" principle), and minimizing potential unintended consequences such as the eradication of base ecosystem trophic levels. Ultimately, these goals will be best achieved through an integrated restoration approach that weighs the overall benefit of the remediation goals with the impacts of destroying thriving habitats.

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GREEN URBAN STORMWATER MANAGEMENT: A FERTILE GROUND FOR COLLABORATIVE ADAPTIVE MANAGEMENT

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At the heart of our work in Cleveland is using vacant lots in the Slavic Village neighborhood—often deemed "ground zero" of the foreclosure crisis—for stormwater management via green infrastructure installations (i.e., rain gardens and bioswales) because the sewer district in Cleveland is under consent decree to clean up its combined sewer overflows which violate the Clean Water Act.

The network of stakeholders is an adaptive component in and of itself in that roles and responsibilities have shifted over the term of our collaboration. We collaborate with the Northeast Ohio Regional Sewer District (under consent decree to use green approaches), the Cleveland Botanical Garden (with strong interest in repurposing vacant land for green use), the Slavic Village Development Corporation (neighborhood redevelopment NGO with strong community ties), researchers at the Ohio State University studying pollinator habitat and the use of dredge soil, the local land banks (to get access to vacant properties), and hydrologists at the USGS. Through community meetings we have sought input on our plans and design from the residents and developed ways to optimize community benefits (increased property value is one goal of the project, in addition to treating stormwater and pollinator habitat provision).

As for traditional adaptive management (AM), the stormwater component of the project takes an AM approach. Our experimental design involves multiple treatments and controls, expansive monitoring, thresholds for runoff retention, and interventions to take when those thresholds are not being reached or are exceeded. In a nutshell, we will bring green infrastructure lots "on-line" in an iterative manner as monitoring indicates additional retention capacity is needed to reach our treatment thresholds.

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EVALUATING BEST MANAGEMENT PRACTICE EFFECTIVENESS TO INFORM DECISION MAKING IN THE CHESAPEAKE BAY

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Across the 64,000 square miles of the Chesapeake Bay Watershed jurisdictions, organizations and individuals are implementing Best Management Practices (BMPs) to reduce nutrient and sediment pollution to the Bay and its tidal waters. New practices and technologies add to the growing number of management options. In order for managers to make informed decisions, it is essential that there be a consistent, scientifically defensible and transparent method for defining the effectiveness of BMPs.

The Chesapeake Bay Program is a regional partnership that leads and directs Chesapeake Bay restoration and protection. Seeking to use the latest science to inform decision making and policy, the Partnership convenes panels of experts to evaluate each BMP using the best currently available research. Panels re-evaluate existing BMP definitions as the best available knowledge improves and changes.

A necessary challenge for the expert panels is to evaluate BMPs for their effectiveness in real world conditions with varying soils, hydrology and management intensity. A challenge for Chesapeake Bay partners and stakeholders is to then come to agreement on adopting the expert panel recommendations. This presentation will share successes and lessons learned from recent and ongoing BMP evaluations, and offer insights to other regions implementing nutrient and sediment pollution reduction practices to restore water quality.

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EXPERIMENTAL ESTABLISHMENT OF PROPAGATION STRIPS FOR LONGLEAF GROUNDCOVER PLANTS: IMPLICATIONS FOR RESTORATION

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In autumn 2010 we initiated an experiment to test three approaches for establishing seedling plugs of longleaf pine ground-layer plant species. The original purpose of the study was to evaluate methods for establishing propagation strips but the results also have implications for restoration. The planting site was an old agricultural field at Clemson Pee Dee Research and Education Center near Florence, SC. The field site was dominated at the beginning of the study by the alien turf-grass Bermuda grass (*Cynodon dactylon*) with the native broomsedge (*Andropogon virginicus*) also abundant in patches. The site was upland sand suitable for longleaf understory. Three experimental treatments were applied: (1) burn only, (2) burn and herbicide, and (3) burn, herbicide, groundcover cloth. Herbicide was Round-Up (glyphosate) applied in several treatments over the prior growing season until bermuda grass was entirely killed. We did not use a pre-emergent for fear of damaging the planting material. The experimental treatments were assigned randomly to 2-m wide planting strips, and 3 such strips (one per treatment) comprised a sub-block. Sub-blocks were nested within 3 large blocks located in different sections of the field.

The experiment consisted of 16 sub-blocks of 3 strips each for a total of 48 planting strips. Fourteen different species were planted, typically one species per sub-block although two of the sub-blocks comprised combinations of species. Plantings included three grasses (*Sorghastrum elliottii, Aristida lanosa, Schizachyrium scoparium*), one legume (*Tephrosia virginiana*), and 10 broad-leaf forbs (*Liatris graminifolia, Liatris squarrosa, Vernonia angustifolia, Pityopsis graminifolia, Helianthus atrorubens, Solidago odora, Coreopsis major, Ageratina aromatica, Symphyotrichum (Aster) concolor and Sericocarpus (Aster) tortifolius*). All of these are dominant to common species of undisturbed longleaf groundlayer on subxeric sites within the “wiregrass gap” region of central South Carolina Coastal Plain. The majority of the planting was accomplished during the fall/winter of 2010/2011.

In early March 2013 we harvested standing biomass from all species and treatments. Biomass was air-dried and weighed to the nearest gram. Rather unsurprisingly, since this is standard horticultural practice, the combination of herbicide plus groundcover cloth produced the highest production for all species. Results of the other two treatments were more interesting. The three grass species performed best in the herbicide treatment whereas the broad-leaved forbs did as well or better in the burn only treatment. Negative impacts of herbicide on forbs could not have been due to direct effects since herbicide was also applied to the fabric strip, which performed the best of all treatments. These results suggest interesting hypotheses of facilitation succession and niche differentiation on establishment of longleaf ground-layer plants in old fields.

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INCENTIVIZING LOW IMPACT DEVELOPMENT: DEVELOPING AND PILOTING GREEN SHORES FOR HOMES

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In March 2010, the U.S. Environmental Protection Agency (EPA), under the Puget Sound Watershed Management Assistant Program, awarded the City of Seattle a four year grant to research incentives for removing bulkheads and improving the ecological function of residential shorelines along Lake Washington, Seattle, USA and the Salish Sea in San Juan County, WA USA. Green Shores for Homes builds on Seattle's existing Green Shorelines guidelines (Seattle DPD 2010) by developing and testing incentives to protect and improve ecosystem function and processes along shorelines of single-family waterfront homes. The assessment framework, Green Shores for Homes, is based on the existing Green Shores for Coastal Development Rating System (CDRS) developed by the Stewardship Centre of British Columbia (www.greenshores.ca and www.stewardshipcentre.bc.ca). The Coastal Development Rating System provides a voluntary rating certification process for coastal developments modeled after the highly successful LEED^{tm} Green Building rating system.

The City of Seattle pilot tested Green Shores for Homes credits on Lake Washington, building on previous multi-jurisdiction efforts to facilitate alternatives to shoreline alteration. San Juan County participated as a project partner and pilot tested Green Shores for Homes in marine coastal locations. In September 2010, Islands Trust, a federation of local governments within the BC Gulf Islands of Canada joined this initiative as a transboundary partner. Members of the Green Shores Technical Working Group, which oversaw the development of the Coastal Development Rating System, coordinated the development of the Green Shores for Homes credit system.

Implementing Green Shores for Homes simultaneously in British Columbia, Canada and Washington State, USA, as well as in urban freshwater and rural marine shoreline environments will provide a model for how other jurisdictions can protect restore shoreline ecological function from impacts of growth.

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HEALTHY FORESTS AND RENEWABLE ENERGY

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Boulder County has matched forest restoration with renewable energy production for a win-win project for the environment. The County Parks and Open Space Department manages 30,000 acres of forests. These forests have been altered by over 130 years of fire suppression. Forests that once supported 30-50 trees per acre may now have 3000 trees per acre. They are subject to catastrophic wildfires, large scale insect outbreaks like mountain pine beetle, and overall forest health declines.

In order to address these issues, Boulder County has been actively managing these forests for 30 years. Woody biomass material from forest restoration thinning projects had no viable market in Colorado; therefore the treatment fuels were burned in slash piles or chipped and redistributed on the forest floor.

In 2005, the county committed to make use of the forest thinning biomass. We installed a 125 boiler horse power Messersmith biomass heating system to serve as district heat for five Boulder County buildings. For eight years this system has been operating using local wood from local forests. The wood chips used for heating are products of both county forest management and more recently from private property owners thinning their forests for mountain pine beetle or fire mitigation.

This project has reduced costs for heat, reduced carbon emissions, and provided an outlet for woody biomass that was not previously available in the Front Range of Colorado. Since its inception, several local, state and federal agencies have installed similar systems in Colorado, including a new system that recently fired up to heat the Boulder County Jail.

Healthy forests and renewable energy heat, it's a perfect combination!

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DRIVERS OF PLANT COMPOSITION IN RIPARIAN AND ISOLATED SWAMPS OF SOUTHEASTERN CANADA

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Swamps are abundant in southern Québec (Canada) but they suffer from constant anthropogenic pressure like urbanization, agriculture and drainage. They provide many ecosystem services like water purification and retention, attenuation of flooding, reduction of river bank erosion and biodiversity support. Despite their importance, swamps remain poorly studied in temperate and boreal regions. This project aimed at better understanding swamp plant communities and vegetation structure based on site position in the watershed, especially their hydrological connectivity with rivers, as a basis for future conservation and restoration practices. During the summer of 2012, we visited 28 riparian and 28 isolated sites distributed uniformly in two watersheds. The structure and abundance of more than 300 plant species were described in 213 circular plots of 400 ha. Soil physical characteristics, microtopography, topography and land use data were also collected. Isolated and riparian swamps showed differences in vegetation composition.

The distinction in the vegetation composition was strongest for the herbaceous broad-leaved plants and pteridophytes strata. The most important factors driving this pattern were associated with soil wetness that impacted plant establishment. Vegetative strata of pteridophytes and herbaceous broad-leaved plants were dominant in riparian swamps whereas bryophytes and ericacea strata were more important in isolated ones, perhaps as a result of paludification. Furthermore, isolated swamps had higher mean α diversity than riparian swamps. In addition to the improvement of our knowledge of swamp biodiversity in northeastern North America, our results suggest that swamps should be managed, protected and restored in accordance with their hydrological connectivity across a watershed.

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EVALUATION OF SUCCESS IN TAMARIX CONTROL EFFORTS IN THE COLORADO AND RIO GRANDE CATCHMENTS

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Efforts to control *Tamarix* invasion in the US have been very intense during the last two decades. Years of trials and errors with a diversity of techniques employed for *Tamarix* eradication, including the biocontrol agent *Diorhabda carinulata*, have gradually increased the effectiveness in keeping stable and even reducing *Tamarix* populations in many watersheds. However, even though *Tamarix* removal effectiveness is today higher than when these efforts began decades ago, most of the restoration works that have been done have not been evaluated systematically. When this evaluation has occurred, it has been usually local (river reach), limiting the finding of general patterns that may guide restoration elsewhere. Up to date, only two works have evaluated success of multiple *Tamarix* removal projects at large spatial scales (Harms and Hiebert, 2006 and Bay and Sher 2008). Harms and Hibert's work was based on data collected in 2003, only two years after the first release of *D. carinulata*. Bay and Sher (2008)'s field work was done in 2005 and focused on restored sites where active revegetation, a less frequently used restoration practice, had taken place.

We recently launched a new project to implement an integrative evaluation of *Tamarix* control efforts in the Southwest of US for the last two decades. A database of more than 250 sites (removal, removal and plantations, reference, control and biocontrol) in different river reaches of the Upper, Lower Colorado and Rio Grande catchments is currently being collected. The database includes information on plant composition and four potential groups of factors determining success: (1) hydrology, (2) soil, (3) meteorology and (4) management/removal techniques and site history. Different metrics of success will be discussed and calculated using the plant composition information collected in reference and control sites. Then, multivariate statistical models will be built to discuss the contribution of the different group of factors in determining success. We hope these results will help us to optimise resources devoted to *Tamarix* control in the future.

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RELATIVE IMPORTANCE OF SPATIAL COMPONENTS OVER LOCAL FACTORS IN PLANT SUCCESSION OF RIPARIAN ZONES RESTORED BY PLANTATIONS

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Three main mechanisms might promote the restoration success of plant communities: the presence of target species in the regional pool determined by landscape parameters, the ability of species to reach restored sites influenced by spatial components and the establishment of species at the reached sites depending on local factors. The importance of these three mechanisms was assessed in tree-planted riparian zones among two agricultural watersheds of southeastern Canada. Botanical surveys were performed in 53 tree-planted riparian zones from 3 to 17 years ago, and in 14 riparian forests. Sixteen local factors including restoration, agricultural, hydrological and soil parameters were collected. Three landscape components were measured in 500 m wide buffer. Spatial components were modelized using Asymmetric Eigenvectors Maps.

Plantations became similar to riparian forest communities 12 years after tree planting. Elevation above river, tree cover and crop type were key local factors, while the proportion of forests was the only important landscape factor. However, they, respectively, contribute to only 5% and <1% to plant composition, while spatial components account for 25% (of which 10% interact with local factors). As tree cover increases, forest plant communities are effectively restored by the replacement of heliophilic and weed species by sciaphilic and ferns species. Spatial components suggest improving restoration success by planting trees from upstream to downstream. Propagules of forest species will thus be enabled to reach the restored riparian zones by hydrochory where local factors will favour their establishment.

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BLOODROOT (*SANGUINARIA CANADENSIS)* AS A DETERRENT TO THE SPREAD OF INVASIVE GARLIC MUSTARD (*ALLIARIA PETIOLATA)*

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The invasion of garlic mustard (*Alliaria petiolata* (M. Bieb.) Cavara & Grande) has been devastating to the understory species of deciduous forests of eastern North America due to its chemical suppression of mycorrhizal fungi symbiosis. Following a previous study finding that high densities of the spring ephemeral bloodroot (*Sanguinaria canadensis* L.) are able to inhibit the nearby establishment of *A. petiolata*, further investigation was commenced as to the viability of its use in management. A seed germination bioassay was conducted, exposing *A. petiolata* seeds to sanguinarine, the predominant root exudate of *S. canadensis*, to determine if seed germination or viability are altered by its presence. Following scarification and treatment with a 10^{-3} gibberellic acid solution, seeds were exposed to treatments of sanguinarine solution [0(control), 7.03, 14.06, 28.13, 56.25, 112.5 or 225 µg/mL] for two weeks. Seeds remaining ungerminated after this time were removed to new media for two weeks to determine if the response was easily overcome; any remaining unchanged were then tested for viability using tetrazolium chloride. Viability was found to not be significantly affected; however the 225 µg/mL treatment provided conditional suppression. A subsequent bioassay was conducted to identify how long this suppression could remain in effect and whether, in addition to the reduction of light from the closing canopy, the competitive ability of seedlings would be reduced. *A. petiolata* seeds were prepared as before, then exposed to 200 µg/mL sanguinarine solution for 2, 4, 6, or 8 weeks while light levels were gradually reduced to emulate canopy closure. A significant delay in germination was achieved. As *A. petiolata* and *S. canadensis* are amongst the earliest plants to appear in spring, this delay provides other neighbouring plants the opportunity to outcompete the invader for resources.

The alteration of the ant community by *A. petiolata* is also an important consideration if self-sustaining deterrence is to be achieved as *S. canadensis* seeds are ant dispersed. Four deciduous forests in the Waterloo-Guelph region were used as study sites - two fragmented, urban woodlots and two larger, semi-rural protected areas; sampling sites containing bloodroot alone were designated as 'control' while those designated as 'invaded' contained either both bloodroot and garlic mustard or garlic mustard alone. Using pitfall traps and Winkler litter extraction, it was found that ant species richness and diversity were not significantly altered by the presence of garlic mustard, but were affected by fragmentation. This indicates that in urban woodlots, *S. canadensis* and its seed-dispersing ants may require supplementing to achieve self-sustaining management results.

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MANAGING SALINITY AND SOIL MOISTURE ALONG REGULATED RIVERS: APPLIED RESEARCH TO ENHANCE RESTORATION SUCCESS

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During the 1900s, extensive river regulation infrastructure was installed to provide flood control, allow diversions for agricultural and municipal water use, and generate hydroelectric power. These programs resulted in dramatics changes to ecosystems dependent on natural flows. Many programs are underway to re-create at least a portion of the historic aquatic, emergent and riparian ecosystems along impounded rivers. The Lower Colorado River (LCR) Multi-Species Conservation Program will re-plant over 2,900 ha (7,200 ac) of historic floodplain, no hydrologically disconnected from the river, with native riparian vegetation. These areas are intended to support wildlife while allowing continued water diversion and power generation. “Restoration” in this context must overcome many challenges. Natural riparian regeneration is limited or absent due to the lack of overbank flooding. Once established, vegetation must be supported by irrigation if groundwater depth is excessive. Floodplain soil salinity is often elevated, and irrigation above shallow groundwater can exacerbate salinization, causing vegetation stress or mortality. Two pilot projects have been completed on the LCR to determine baseline conditions, determine appropriate monitoring techniques, and optimize irrigation to support riparian vegetation.

Between 2010 and 2013, soil and groundwater salinity was monitored at three riparian restoration sites, and a salinity model was used to estimate the amount of irrigation required to sufficiently leach salts. For most sites, irrigation to support planted riparian vegetation maintained acceptable soil salinity. In several cases, irrigation could be reduced for water savings. Conversely, at poorly drained sites, irrigation application must be increased to exceed potential evapotranspiration to maintain acceptable salinity. Groundwater salinity was controlled by incoming subsurface flows. Thus, managers must consider adverse effects of salinity management on down-gradient groundwater, soils, and vegetation.

To assess irrigation distribution and soil moisture availability, a pilot project was conducted at a 30 ha (74 ac), surface-irrigated riparian creation site in 2012 and 2013. Automated data acquisition systems were installed with a combination of off-the-shelf and custom-built equipment. For most of the site, poor irrigation distribution was observed, with extensive percolation near the water source and little applied water at the far end of the field. Irrigation efficiency and moisture retention were greater in finer-grained areas. Ongoing efforts include modeling of irrigation events to analyze alternate irrigation schematics to improve distribution uniformity, reduce percolation, and ultimately reduce the required volume of irrigation water.

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NATURE REDUCES THE IMPACTS OF STORMS. WHAT'S NEXT?

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Natural habitats reduce damages to coastal regions by mitigating against the impacts of storms and rising seas. Unfortunately, all existing habitats cannot be fully protected in the face of increasing coastal development and rising seas. As a result, local stakeholders are often faced with the difficult task of deciding where they matter most by choosing which habitats and ecosystem to conserve or restore with their limited resources. This task requires them to understand how habitats in their area reduce the most their coastal exposure and where people will benefit the most from this reduction.

The Natural Capital Project, in partnership with The Nature Conservancy, is coming up with interesting approaches and tools to evaluate and communicate where dollars are best spent on natural infrastructures to protect coastal communities during storms. These approaches quantify the way in which existing or restored natural habitats help reduce the exposure of diverse U.S. regions to coastal hazards as well as the vulnerability of the communities that reside in those regions.

In our talk, we will provide details on this approach, and present results from some of our analyses conducted in the northeast. In particular, we will show how sand dunes, coastal marshes and other natural habitats in those states can help protect people against the impacts of storms. We will also show examples of how our approach and tools can help inform hazard risk reduction plans by quantifying the change in coastal protection benefits caused by the addition of new habitats via restoration efforts or by the degradation of existing habitats. Finally, we will demonstrate how one can use our approach to better inform the allocation of restoration and/or conservation resources for the benefits of coastal communities.

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OVERVIEW OF UNCC COASTAL REMEDIATION PROGRAMME IN SAUDI ARABIA

Martin Guard
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Military conflict can have major consequences on the environment and is often further complicated by the presence of remnants of war and unexploded ordnance in the affected areas. One of the worst examples of large-scale environmental damage occurred during the invasion of Kuwait by Iraq's forces and its subsequent liberation by Allied forces in 1991. In Kuwait approximately 700 oil wells were set on fire by the retreating forces with other wells simply allowed to release vast quantities of oil into the desert that led to the formation of over 300 oil lakes. Moreover vast areas were covered in tarcrete caused by the fallout of oil and soot from oil well fires. In Saudi Arabia over 50% of the coastline was severely contaminated by the largest marine oil spill in history. Extensive environmental damage was also suffered in the northern deserts from the construction of military encampments, military activities and the movement of a high number of military vehicles and troops in the allied offensive. In Jordan and Iran the main environmental impact was the degradation of the rangeland as a result of refugee immigration whose livestock grazed the vegetation beyond its carrying capacity. The United Nations Compensation Commission (UNCC) was created by the U.N. Security Council in 1991 to resolve and pay claims arising from Iraq's invasion and occupation of Kuwait. The Commission received and acted upon 170 environmental claims ('the F4 claims') totalling approximately US$85 billion and resulting in awards of US$5.4 billion for environmental, natural resource, and public health damages. The Follow-up Programme for Environmental awards established in December 2005 represents a co-operative process between the four claimant Governments, the Government of Iraq and the UNCC to successfully implement in a technically sound manner the F4 environmental projects that are both unprecedented in size and complexity. Under Decision 258 a set of guidelines and measures were provided to ensure transparency and to provide mechanisms for monitoring and reporting on the financial and technical requirements of the restoration and remediation projects implemented by the claimant countries. Oversight of the programme was conducted by the UNCC Secretariat comprised of a core staff team of technical and financial officers and the Independent Reviewers consisting of eminent experts in fields relevant to the environmental projects reporting to the UNCC Governing Council. Both the Secretariat and the Independent Reviewers work cooperatively with the claimant Governments to assist them to implement the Programme. In Saudi Arabia four awards were provided with a total value of US$1.16 billion. In the northern deserts, remediation of military fortifications through the removal of berms, walls and trenches was undertaken followed by active revegetation of the desert within 8 revegetation islands each covering 6 km^2. Along the coast interventions include restoration of existing as well as the creation of new salt marsh drainage channels to reactivate hydrological drainage and encourage recolonisation of the marsh system. Asphalt pavement that impacted many inland bay areas will be removed and experiments utilising removal of algal mats that have hindered natural recovery and the tilling and mixing of sediments to help remove residual oil contamination have been tested. It is also planned to designate offshore islands and mainland site as marine protected areas as compensation for the damage that occurred in coastal areas. Under Decision 269 Saudi Arabia was requested by the Governing Council to establish five specific systems and controls and upon their establishment in 2012 the mandate of the Follow-up Programme for Environmental Awards was declared fulfilled in respect of Saudi Arabia and the programme closed. Ongoing oversight of project implementation and progress was thereafter the responsibility of the Kingdom of Saudi Arabia.

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MULTIPURPOSE WETLAND CREATION AND RESTORATION TO IMPROVE WATER QUALITY AND WILDLIFE HABITAT IN COASTAL URBAN BAYOUS

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Coastal streams and bayous within the coastal zone of urban cities like Houston, Texas have undergone significant loss of riparian habitat including elimination of oxbow wetlands and tributary wetlands. The construction of wetlands at the site of a former oxbow lake and/or stream meander on property owned by the University of Houston - Clear Lake was conducted to improve water quality through reductions in pollutants loads to the adjacent Horsepen Bayou in Harris County, Texas. In addition, the project was designed to recreate wetland habitat for fish, amphibians, reptiles, wading birds and other wildlife. Runoff from approximately 21.5 acres of University of Houston-Clear Lake property (including heavily used parking lots, roads and university buildings) was routed through this newly constructed wetland complex. The primary objective of the wetland complex was to remove sediments, nutrients, and bacteria before entry into Horsepen Bayou. Prior to construction, the site consisted of a single deep retention pond (Alligator Pond) with limited shoreline habitat and negligible shallow water habitat. The major tributary and drainage route into the pond consisted of grass-lined ditches that were had been previously mowed and maintained and only held water immediately and temporarily after a rain event. Alligator Pond had a stand-pipe which regulated water flow out of the pond and into Horsepen Bayou. The wetland complex was designed to increase the retention time of stormwater by enlarging the ponded shallow wetland areas.

This project created 0.56 acres of wetland and converted 0.25 acres of the original borrow pond (Alligator Pond) and grass-lined ditches into additional wetland areas. Post-construction the wetland area was void of vegetation, and a strategic planting was executed to introduce specific wetland plants known to perform well for stormwater treatment and as habitat for small mammals, birds, reptiles, amphibians, and fish. After planting the wetland, the site was closely monitored for several years. One year following the planting, an extensive vegetation survey was completed to document the coverage, growth, and success of the original planted wetland vegetation and to evaluate potential recruitment and colonization of opportunistic species. This survey documented the importance of natural recruitment of other plants into a newly created wetland. One year after construction a total of 135 species were documented within bank full of the created wetland site. Less than 10% of these species were planted post-construction. Through deployment of game cameras, seining, plankton tows and benthic grabs we also documented the extensive utilization of this site by a variety of fish and wildlife. Further benefits derived by this project include expanded educational programs on wetlands and improved aesthetic landscaping.

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LOUISIANA'S BARRIER ISLANDS: THE FIRST LINE OF DEFENSE FOR COASTAL COMMUNITIES

PJ Hahn
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Plaquemines Parish is home to many of the successful barrier island restoration projects implemented by CWPPRA and CPRA including Pelican, Scofield, Shell, Bay Joe Wise Chaland Headland and Chenier Ronquille. The residents and businesses in coastal communities in Plaquemines Parish fervently support these projects and recognize their importance as the first line of defense against the threat of increasingly violent and frequent tropical storms.

Plaquemines Parish also advocates for building these crucial components of storm defense to higher elevations to ensure sustainability and long term protection. Modeling studies conducted by the Parish in coordination with the U.S. Army Corps of Engineers Research and Development Center (ERDC) demonstrated that constructing barrier islands to elevations of +10 to +12 feet could knock down storm surge of a 100-year storm as much as 3 to 4 feet in addition to significant wave height reduction. Another CPRA funded and Parish-led study assessing the sustainability of coastal restoration projects indicated that higher barrier islands are more likely to survive and provide benefits after a powerful Category 3 hurricane.

The continued restoration and bolstering of our barrier island system will ensure that the first line of defense for coastal communities can provide enduring storm protection.

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FEDERAL URBAN WATER PARTNERSHIP-PHILADELPHIA AND THE URBAN DELAWARE RIVER

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Urban water ecosystems have long been neglected, especially from the perspective of comprehensive restoration, both ecologically and socio-economically. The primary goal of the Urban Waters Federal Partnership (UWFP) is to reconnect urban communities, particularly those that are overburdened or economically distressed, with their waterways by improving coordination among federal agencies and collaborating with community-led revitalization efforts to improve our Nation's water systems and promote their economic, environmental and social benefits.

The urbanized area along the Delaware River throughout the Greater Philadelphia region has historically experienced a significant loss of economic benefits and environmental services provided by the river. Numerous local and regional initiatives are underway to reduce the negative impacts of urbanization on the quality of the river while reclaiming and restoring impacted riverfronts and economically revitalizing depressed areas. Challenges include stormwater management, legacy contamination, erosion and flooding control, source water protection, restoring lost habitat, enhancing overall waterway health, protecting community investments, pursuing environmental justice, and promoting public access.

Due to the geographic extent of the Delaware River Watershed and the diverse set of environmental and social issues at hand, restoration requires a larger-scale focus. Together with its associated landscape, the Delaware River is an American treasure, truly iconic in scope and purpose. To keep the Delaware River sustainably healthy, a wide range of federal, state, regional, local, and non-governmental organizations (NGOs) are banding together to share resources to meet planned objectives. The greatest challenge will be to ensure that current work and planned actions by interested organizations are linked together to yield cost-effective investments in time, ideas, and funding that will more fully address contemporary conservation needs.

A keystone project of the Delaware River UWFP is to restore approximately 30 acres of tidal wetlands and associated habitat along the Central Philadelphia Waterfront, while increasing community access and recreation. This is a significant amount of re-created tidal wetland acres in the urban corridor and the benefits as well as challenges are monumental. Much of the intertidal wetland habitat along the Delaware River's edge has been affected by dredging and filling and replaced with hardened shores or bulkheads. The project will restore vital habitat for numerous aquatic species, including endangered species, and provide critical ecosystem services, including those relevant to climate resiliency. In addition this project will be transformative in terms of accruing social and public health benefits for underserved communities.

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IMPORTANCE OF ADAPTIVE MANAGEMENT IN DEVELOPING EFFECTIVE RESTORATION METHODS

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The primary goal of the 2009-2013 Coastal Environments – Remediation and Restoration Program funded through the United Nations Compensation Commission and implemented by Saudi Arabia's Presidency of Meteorology and Environment is to restore the natural distribution and abundance of key flora and fauna, hydrology, and other ecological processes to Arabian Gulf salt marsh and tidal flat habitats damaged as a result of the 1991 Gulf War Oil Spill. Substantial challenges to success of the program included working in remote, environmentally hostile locations; coordinating activities to address a variety of environmental stressors; and management of contractors with little experience in environmental restoration projects. However, application of adaptive management to the design, implementation, and monitoring of progressively larger remediation projects improved progress toward restoration goals, reduced waste management and disposal costs, and improved management and results of subsequent remediation projects.

Adaptive management was implemented as "alternative remediation strategies conducted in an experimental framework" (e.g. Zedler 2001). The "experimental framework" included statistical replication, and it began with specific questions related to remediation activities such as: excavation of tidal channels; transplantation of mangroves (*Avicennia marina*) to tidal channel banks; beneficial re-use of spoil to create new micro-habitat for marsh flora and fauna as "marsh mounds"; and tilling un-vegetated tidal flat habitats to reduce oil concentrations and break up physical barriers. Small-scale studies and pilot projects from a few to tens of meters in size were developed and implemented at the onset to address these questions. Statistically defensible conclusions from smaller projects were used to design and carry out demonstration projects up to several hectares in size. Subsequent "full scale" projects from tens to hundreds of hectares each were designed, managed, and monitored in ways that often allowed for mid-course corrections in the case of large remediation contracts with durations exceeding 1 year.

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THE WORKING LANDS FOR WILDLIFE PARTNERSHIP – A NEW PARADIGM IN CONSERVATION

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Given the basic tenets of NRCS Conservation Initiatives (science based, targeted funding, outcome-oriented, partnership driven), the premise behind WLFW is to provide a new paradigm in the NRCS approach to species and landscape level conservation. This paradigm recognizes and embraces the value of voluntary conservation, prevents or reduces the regulatory burdens associated with possible Endangered Species Act (ESA) listings and seeks to find the win-win for working lands or production agriculture and wildlife conservation.

The nation's rural landowners – its farmers, ranchers and forest owners – provide not only food and fiber for the world, but also a host of environmental benefits, including habitat for wildlife, opportunities for outdoor recreation, and scenic landscapes. Nearly two thirds of all species federally listed as threatened or endangered have populations on private lands, as do all of the nation's game species. Through the Working Lands for Wildlife Partnership, the Natural Resources Conservation Service (NRCS) and U.S. Fish & Wildlife Service (FWS) provide landowners with technical and financial assistance to achieve specific conservation goals. The partnership has three primary objectives:
Provide agricultural producers a pathway for compliance with the Endangered Species Act
Help restore populations of specific declining wildlife species through habitat restoration
Strengthen and sustain rural economies by restoring and protecting the productive capacity of working lands.

NRCS and FWS are targeting species whose decline can be reversed given sufficient resources and landowner participation. One example of this targeted effort involves the gopher tortoise in the Southeast U.S. This effort blends with the ongoing Longleaf Pine Initiative and other species specific efforts partners are involved in. In the last 2 years, NRCS has developed conservation plans on over 200,000 acres to improve gopher tortoise habitat and obligated over $20 million in financial assistance. NRCS has additional partnerships in place with many different state and local agencies, NGO's and non-profit organizations to increase our capacity to deliver conservation. The Partnership demonstrates through innovative use of existing tools and resources, that productive working rural land is compatible with the needs of sensitive wildlife species. Government can partner with private landowners and provide a win for not only small businesses and rural communities but also for the environment and our quality of life.

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A FIVE YEAR STUDY OF CONTAINER AND BAREROOT TREE SURVIVAL ON A STREAM RESTORATION PROJECT IN CENTRAL NORTH CAROLINA

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Throughout North Carolina, stream restoration has increased over the past decade due in part to state and federal requirements for compensatory mitigation. Planting stream buffers with riparian trees is also a required part of the restoration plan and a minimum 5-year monitoring period is generally expected to meet permit requirements. Successful vegetation establishment at the end of the 5-year period is defined as 130 live planted stems per hectare. The local nursery industry grows native riparian trees either as bareroot plants or containerized plants. Bareroot trees are less expensive than potted trees but there has been debate in the local nursery industry regarding which type has better survival rates when planted on stream buffers. This experimental trial tested the theory that containerized trees have better survivability than bareroot trees on a stream restoration site.

In central North Carolina, a stream mitigation project to offset campus impacts was completed in 2004. The restored stream was located at the College of Veterinarian Medicine on the campus of North Carolina State University in Raleigh, North Carolina. The restored channel was approximately 700 feet long with wide buffers on each side of the stream. A randomized complete block design was employed with experimental vegetation plots to determine if there were significant differences in survival and growth rates of container and bareroot riparian trees on this site. Each plot measured 15m X 15m and within each plot, five species of riparian trees were planted in each of five rows located horizontally to the channel. Each row represented a gradient treatment. The planted tree species included *Betula nigra* (river birch), *Liriodendron tulipifera* (tulip poplar), *Fraxinus pennsylvanica* (green ash), *Platanus occidentalis* (sycamore), and *Quercus michauxii* (swamp chestnut oak). Container trees were approximately 2 years old and grown in nursery standard 1-gallon pots. Bareroot trees were approximately 1.5 years old and except for *F. pennsylvanica*, were nearly equal in height to the container trees. Data on tree survival, stem diameter, tree height and gradient response were collected annually for 5 consecutive growing seasons. Bareroot treatments resulted in 50 percent mortality in the first growing season while container treatments had 25 percent mortality in the same season. *F. pennsylvanica* had higher survival rates for both bareroot and container types than other species. There was no significant difference in heights or diameters of bareroot trees and container trees by the end of the fifth growing season. Additionally, overall survival of all types and species decreased from the streamside location upslope to higher landscape locations.

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REFORESTING APPALACHIAN SURFACE MINES: A BLACK WALNUT PILOT STUDY (NURSERY STOCK VS. SEED, WITH OR WITHOUT TREE SHELTERS)

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Surface mining for coal in the Appalachian region of the U.S. has resulted in large scale alteration of the landscape, with many areas differing greatly from the eastern deciduous forest vegetation that was present prior to mining. Restoration efforts utilizing the Forestry Reclamation Approach have primarily used nursery seedlings during the tree planting phase, which limits tree planting to the winter dormant season. Tree shelters are often recommended for use when planting seedlings to protect them from herbivory, but may not be necessary when planting from seed. Research on the use of direct planting by seed in this region is limited, but if successful, could open up an additional planting season, as well as potentially reduce planting costs. In Fall 2011, a collaborative small-scale research project was designed to explore whether direct seeding could be successful on a surface mine that had previously been reclaimed. A 2x2 factorial design was used to explore two main treatment effects- planting type (by seed or 1-year nursery stock) and use of tree shelter (present or absent). Three replicate plots of each of the four treatment combinations were planted with black walnut (50 per plot). Survival, height and diameter were calculated for measurements taken after the second growing season, and height growth rate was calculated based on differences between the first and second growing seasons. As expected, survival ($p=0.001$), height ($p<0.0001$) and diameter ($p<0.0001$) were significantly greater for the nursery seedlings compared to those from seed. Height growth rate was significantly higher ($p=0.021$) for the plants from seed. Interestingly, interaction of the two main treatment effects showed there was a trend for shelters to benefit nursery seedlings, but to hinder those plants from seed. Further research is needed, but this preliminary data shows promise for the use of direct seeding in the fall without the use of tree shelters using black walnuts.

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RESTORING FORESTS ON MINE LAND IN APPALACHIA

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More than 600,000 ha of mostly forested land have been disturbed by coal mining in the eastern United States. Most have been sown to non-native grasses and abandoned; they are largely unproductive woody scrub. The Appalachian Regional Reforestation Initiative (ARRI) is a broad-based citizen/industry/government program working to encourage the planting of productive trees on active coal mine lands and abandoned coal mine lands. The multiple benefits from this initiative include restoration of clean water and air resources, carbon sequestration, soil conservation, wildlife and endangered species habitat, recreational opportunities, and timber production. Using a combination of private and governmental resources, the program facilitates and coordinates citizen groups, university researchers, the coal industry, corporations, the environmental community, and local, state, and federal government agencies that have an interest in creating productive forestland on reclaimed mined lands. Forestry research conducted by various academic institutions has confirmed that highly productive forestland can be created on reclaimed mined land by using a Forestry Reclamation Approach (FRA). The FRA has five fundamental parts: (1) Create a suitable rooting medium for good tree growth that is no less than 1.2 m deep and comprised of topsoil, weathered sandstone and/or the best available material; (2) Loosely grade the topsoil or topsoil substitutes placed on the surface to create a non-compacted growth medium; (3) Use ground covers that are compatible with growing trees; (4) Plant two types of trees – early succession species for wildlife and soil stability, and commercially valuable crop trees; and, (5) Use proper tree planting techniques. The federal Office of Surface Mining Reclamation and Enforcement and the Appalachian region coal states have determined that this technology can be implemented under the current state and federal regulation. In response to the growing interest in planting trees on previously reclaimed mine sites where reforestation was not attempted, or where the results were undesirable, ARRI created a non-profit organization called Green Forests Work (GFW). The GFW program is an economic development plan for Appalachia styled after the Civilian Conservation Corps of the 1930s that uses the FRA and focuses on restoring ecosystem services on mine-scarred lands while creating jobs in the process. Successful reestablishment of the hardwood forests that once dominated these lands will provide a renewable, sustainable multi-use resource that will create economic opportunities while enhancing the local and global environment. The development and execution of these multi-partner initiatives will be outlined. They may serve as organization models for other groups whose goal is to restore disturbed landscapes on a regional level.

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COASTAL BIOENGINEERING FOR ECOLOGICAL RESTORATION

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Coastal bioengineering is an emerging field related to biological engineering, coastal engineering, aquatic engineering and the biological sciences, which uses engineering techniques, coupled with biological knowledge, to solve coastal challenges including ecological restoration. Louisiana, like many coastal areas, is losing land, with an estimated 1800 square miles of land loss in the last 80 years. This extensive land loss can be attributed to 3 main causes: subsidence (slow compaction of soil particles), erosion, and sea level rise. Purely physical or traditionally engineered solutions appear to be insufficient to fully accommodate, and tend to impact ecosystems negatively. Bioengineered reefs, focused on maximizing biological growth to protect the shoreline and continue to grow to the new relative surface level, may provide both coastal protection and habitat for juvenile fish and other species.

Coastal engineering has traditionally focused largely on hard structures such as groins, jetties and seawalls, as well as massive earthmoving such as in levees. These are costly and invasive. Biological engineers aim to integrate biology into engineering design to enhance function and maximize sustainability. Examples include reefs which are currently being used as breakwater devices in some locations on Louisiana coast. As oysters (*Crassostrea virginica*) begin to grow on these reefs, their strength can increase by a factor of 10, providing a long lasting and biologically dominated artificial reef structure. The engineered reefs are made of porous cement with biological additives, which allows water to flow through, causing more energy dissipation and sediment deposition. As sediment continues to deposit, growth of coastal plants such as *Spartina alterniflora* can help to maintain the structure of this new land.

In a working coast, growing structures that serve economic and pragmatic functions can also provide critical habitat and coastal protection. Another example of coastal bioengineering is the enhancement of coastal ridges termed 'cheniers' after the French for oak, the dominant plant species (*Quercus virginiana*). Engineering to emplace or further protect such ridges is termed 'chengineering' and is another form of creative coastal bioengineering. Each of these techniques uses local flora and fauna, minimizes outside energy and material input and contribute to ecological restoration as well as coastal protection. Enhancing living resources including shellfish, plants and fish, as well as increasing sustainability of the ecology can improve long term sustainability of the coastal environment.

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INCORPORATION OF RESILIENCE AS A GOAL IN ECOSYSTEM RESTORATION: A PACIFIC NORTHWEST (USA) PERSPECTIVE

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Resilience is increasingly put forward as a goal for ecosystem restoration. Defined as the capacity of ecological or social systems to respond to perturbation or changing conditions while continuing essential functions, resilience is an easy concept to understand. Indeed it is one of nine attributes of restored ecosystems recognized in the SER Primer. Evidence to date, however, suggests that this attribute is the least likely to be considered in ecological restoration projects. The primary stumbling block is our general inability to measure resilience. Calls to address this shortcoming have come recently from the Independent Scientific Advisory Board (ISAB) for the Northwest Power and Conservation Council (NPCC), a primary conduit for funding of ecological restoration projects within the Columbia Basin of Washington, Oregon, Idaho, and Montana.

Ecosystems in the Columbia Basin were incrementally altered over a 200-year period through over-harvesting of furbearers, resource extraction, and development of a hydroelectric system that modified riparian and aquatic ecosystems and allowed habitat conversion to irrigated agriculture. Additionally, grazing, fire suppression, invasive species, and increased human population growth and development further modified the landscapes of the Columbia Basin. In the early 1980s, the NPCC launched one of the largest regional restoration programs to recover fish, particularly salmon, and wildlife. The initial goal was one of simply increasing fish abundance, but little success was achieved over a 20-year period despite expenditures in the billions of dollars. By the late 1990s, the ISAB and NPCC began promoting ecosystem and biodiversity elements, although these were largely ignored by those implementing projects. At present, the ISAB is recommending a comprehensive landscape approach to ecosystem restoration in the Columbia Basin that incorporates adaptive management to ensure adaptive capacity, maintenance of biodiversity, and resilience.

This is clearly a tall order, and in this paper, I consider whether measurements of resilience should be used to determine success in ecosystem restoration. Although restoration is taking place throughout the Columbia Basin, it includes a large number of restoration projects and programs. Can we in fact assess a cumulative effect of these activities? Finally, I address the value of including the goal of resilience in an adaptive management strategy.

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RESTORING INDIGENOUS FIRES TO CALIFORNIA OAK WOODLANDS

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While fire is recognized as an integral component of many global ecosystems it is also integral to the laws, lore, and lifeways of many indigenous groups. As such the coupling of fire and culture are interrelated and interdependent in many regions including California. Colonization and subsequent governmental fire policy mandates have disrupted the cultural use of fire. As society grapples with the devastating impacts of wildfires and the loss of biological diversity many indigenous people see traditional fire use as a key to mitigation of devastating losses while retaining traditional livelihoods associated with burning. Indigenous burning in California is a keystone process, which creates heterogeneity of species and habitats while also promoting many culturally significant foods, materials and other resources of value to indigenous communities and society. This research focuses on the restoration of indigenous burning to oak woodlands and the ecological and cultural effects thereof. Preliminary findings and community perspectives of this research will be discussed.

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INCORPORATING CONNECTIVITY AND SPATIAL DYNAMICS IN RESTORATION PLANS

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Highly stressed and declining conditions of natural resources and ecosystem functions are common and well-documented. Critical fish and wildlife habitats have been highly fragmented by human development from expanding global populations. Valued biological and natural systems are further stressed and/or threatened by rapid changes in environmental conditions associated with climate change. In response to these threats, ecosystem restoration and climate adaptation strategies commonly call for the need to address the connectivity of critical habitats and ecological functions in order to increase the resilience and/or recovery of natural systems. Although connectivity is well accepted as a desired management objective, few of the present resource management modeling tools explicitly or effectively address this need. Too often, resources are valued and managed by enhancing the total amount of a desirable habitat or ecosystem function under an implicit assumption that all areas and/or functions within a similar resource category have an equivalent value regardless of the differences of each unit's connectivity. Evaluation of future conditions under varied potential scenarios including sea level rise, development patterns, climate, and management schemes is rare. This presentation explores the importance of, and approaches to, explicitly incorporating the geospatial and temporal dynamics, associated habitat connectivity, entropy analysis, and ecosystem services in restoration and management plans. Utilizing the spatially-explicit descriptions and quantifications of ecological processes and structures, we investigate evidence for relative and absolute scarcity to social and economic ends. This entails investigating important and valuable ecosystem goods and services, such as water supply at times and locations of particular scarcity, as well as intermediary ecological dependencies, such as critical pollinators. Local context is a strong driver for understanding the real values at play. Application scenarios will presented which can be applied towards habitat valuation, sustainable development, mitigation, primary and compensatory restoration, as well as resilience and adaptation planning.

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THE COUNTING CHALLENGE: BMPS IN THE CHESAPEAKE BAY WATERSHED

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Under the landmark Chesapeake Bay Total Maximum Daily Load (Bay TMDL) issued in December 2010 by EPA, federal agencies and jurisdictional partners in the Chesapeake Bay watershed are working together to install and implement Best Management Practices (BMPs) by 2025 to reduce nutrient and sediment loads and achieve water quality standards for the Bay's tidal waters. The Chesapeake Bay Program (CBP) partnership serves as the center point in this effort, as it facilitates the science, monitoring, and decisions needed to maintain accountability and scientific rigor in Bay restoration.

Criticisms, praise, and questions arise from stakeholders as each year moves the CBP partnership one step closer to 2025. The Partnership's comprehensive Watershed Model and other decision support tools are designed to track and assess the cumulative effect of BMP implementation, with the caveat that the current suite of modeling tools do not incorporate lag-times between BMP installation and the benefit to receiving waters (Sanford & Pope, 2013; Chesapeake Bay Program Scientific and Technical Advisory Committee, 2013). Furthermore, a 2011 National Research Council review of the CBP called for greater verification of BMPs. These considerations have led some to ask: Do increases in reported BMPs represent implementation that will eventually restore the Bay, or simply more proficient "bean-counting"?

The Chesapeake Bay Program Partnership has several efforts underway to answer these questions. First, the Partnership has established a review process for BMPs and their effectiveness to reduce nitrogen, phosphorous, and sediment. The review process continues to evolve as the Partnership's diverse stakeholders grapple with the reality of limited resources to conduct reviews and the need to maintain accountability and scientific rigor. Second, the Partnership has formed a Verification Subcommittee and Verification Review Panel to guide the partners as they develop a framework for confirming nutrient and sediment reductions from the full array of BMPs implemented across all sources in the Chesapeake Bay Watershed.

If the partnership achieves its 2025 goals, perhaps a similar approach can be applied to other nutrient- or sediment-enriched watersheds. This presentation will provide the following glimpse of the partnership's BMP review process: its role in achieving the goals under the 2010 Bay TMDL; the merits and challenges of such a process; and lessons for science and policy in watershed restoration.

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WHAT'S NEXT FOR LOUISIANA DREDGED BARRIER ISLANDS

William H. Hanson
Great Lakes Dredge & Dock Company, LLC, Oak Brook, IL, USA

Although beach nourishment and coastal protection projects have been around for a while, only recently have large scale projects moved past the talking stage to the execution stage. Engineers have learned a lot about how to plan and develop barrier island project design, win consensus during planning and permitting phases, and then actually dredge and construct barrier islands.

With all attention on the future of the Louisiana coastline, experience from recently completed projects becomes essential in deciding which projects will get done and how. This presentation will provide a brief discussion of lessons learned that will hopefully help guide decision makers on how best to accomplish the important work remaining.

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PUTTING HUMANS BACK IN THE ECOSYSTEM: DEVELOPING HUMAN DIMENSIONS TOOLS FOR LARGE ECOSYSTEM RECOVERY PLANNING IN PUGET SOUND

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The Puget Sound Partnership (PSP) in Washington State is tasked with coordinating the recovery of Puget Sound, a social-ecological system that contains iconic species, emerald vistas, diverse cultural heritage, and demands difficult management tradeoffs to support its 4.4 million residents. PSP is building an understanding of the human dimensions that encompass the Puget Sound ecosystem, and developing tools to monitor and synthesize social science information for management and policy decision-making. A team of internal and external planners, ecologists, and social scientists developed a common framework and language to guide restoration strategies, including an integrated ecosystem recovery conceptual model. The model illustrates PSP's assumptions about the social-ecological system's components and relationships, and integrates biophysical and social data. Examples of the model's application in guiding restoration strategies will be described.

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A MODEL FOR IDENTIFYING SITES SUSCEPTIBLE TO CHINESE PRIVET (*LIGUSTRUM SINENSE*) INVASION IN THE APPALACHIAN PIEDMONT

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There is a limited understanding about the characteristics that make certain sites more susceptible to exotic plant invasion than others. This study was conducted to determine the soil and landform characteristics that correlate with Chinese privet (CHP) invasion, and to develop a model to predict the probability of CHP invasion in Piedmont forests. A Landscape Ecosystem Classification (LEC) system – based on the % clay in the B horizon, depth to maximum clay (cm), exposure, terrain shape, and aspect (degrees) – was used to determine the soil moisture characteristics of invaded and uninvaded plots. Additional measurements included the cover classes of CHP and other species, litter depth (cm), slope (degrees), overstory basal area (m^2 ha^{-1}), and soil chemical properties. When CHP cover exceeded 60%, other understory species were largely absent. CHP invasion was negatively correlated with overstory basal area and slope and positively with litter depth and pH. A stepwise logistic regression model containing these four variables was highly sensitive, with an overall accuracy of 78%. Given the accuracy of this model, we propose that it can be used to calculate the probability of invasion in a given area, provided that some basic, readily obtainable site characteristics are known. By identifying the areas that are most likely to be invaded, it could facilitate the early detection and control of CHP, thereby minimizing its impacts and reducing the need for a costly long-term restoration commitment.

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EVOLUTION OF INVENTORY AND MONITORING STRATEGIES AND USING QUALITATIVE DATA TO EVALUATE THE EFFECTIVENESS OF LONG-TERM RESTORATION EFFORTS ALONG THE LOWER RIO GRANDE

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Since 1982, the United States Fish and Wildlife Service has planted native trees and shrubs over nearly 15,000 acres of former agricultural land within Lower Rio Grande Valley National Wildlife Refuge, located in southern Texas, in an effort to restore riparian woodlands. We measured density and relative abundance of dominant canopy and mid-story woody species at sites planted prior to 1997 within seven separate refuge tracts. Data were compared to association-level descriptions of climax woodland-plant communities of the Rio Grande delta. Project effectiveness at each restoration site was evaluated by its similarity to natural communities occurring at sites having similar soils and other site-specific characteristics. Effectiveness of various planting techniques and strategies for future long-term inventory and monitoring will be discussed.

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USE OF APPLIED SCIENCE FOR COASTAL RESTRATION IN THE PONTCHARTRAIN BASIN OF SOUTHEAST LOUISIANA

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The Lake Pontchartrain Basin is a 9,600 square mile watershed and estuary located east of the Mississippi River within southeast Louisiana. Because of Louisiana's crisis of coastal wetland loss and degradation resulting in increased hurricane vulnerability, LPBF has an aggressive coastal program to investigate coastal areas, which yields significant data that can be applied to coastal restoration planning or operations. Research projects have centered on the ecologic health, including, habitat loss, water quality, fisheries, hydrology, of the estuary. This paper summarizes two key projects.

The re-introduction of Mississippi River water into the estuary through artificial river diversions to improve, sustain or build new wetlands is accepted by most scientists as an essential restoration method to offset long term degradation of coastal Louisiana. However, the science of how to best build and operate new diversions and their full positive and negative effects on the estuary is not fully known. LPBF has been investigating various "legacy diversions", which are existing outlets to river water, but generally built for reasons other than coastal restoration. The legacy diversions provide some partial record of the effects of river reintroductions that may inform future design and operation of new diversions.

The Bohemia Spillway is a 12-mile reach of the Mississippi River in which the artificial river levees were removed in 1926 to reduce flood risk to New Orleans. Since the spillway is subject to annual spring flooding, it provides some insight into the nature of the overbank flow and the fate of sediments. The record of lower rates of habitat loss suggests that the wetlands are benefitting from eighty-years of overbank flooding. In 2011, LPBF documented the development of a distributary, later named Mardi Gras Pass, within the Bohemia Spillway.

The Caernarvon Freshwater Diversion has a maximum flow capacity of 8,000 cfs, and was designed to minimize sediment capture and conveyance. Although there was a twelve year delay from the start of operation, in 2004, a small delta became emergent in the outfall area of the Caernarvon Diversion discharge. From 2004 to 2006, classic delta morphology developed and afterward a wetland forest of black willow (Salix nigra) developed. LPBF began planting bald cypress (Taxodium distichum) on the delta and the pro-delta area since 2010, and has found good survivorship and growth rates on trees planted with nutria protection.

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MOBILE BAY NATIONAL ESTUARY PROGRAM THREE MILE CREEK WATERSHED MANAGEMENT PLAN

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Mobile Bay National Estuary Program (MBNEP) worked closely with Dewberry as environmental planning and engineering consultants to develop a comprehensive Watershed Management Plan (WMP) for the Three Mile Creek Watershed which runs through the City of Mobile, Alabama. This plan is necessary to document existing environmental challenges and provide a vision and strategy for achieving a transformation from what is currently a community liability, due to its degraded condition, to an asset celebrated by residents. An essential piece of plan development is the engagement of city, county, state and federal agencies; nongovernmental organizations focused on community and environmental health; community resources such as hospitals, schools and businesses; and the congressional delegation. Engaging the entire community is necessary for project success and to demonstrate how both private and public objectives can be achieved for community environmental and economic development benefits. The WMP definitively identifies and categorizes watershed/water quality issues and problems, identifies climate change vulnerabilities, reasonably ascertains the magnitude of restoration and adaptation potential, identifies human and financial capital needed to implement best management practices and engineering or other actions, institutes reasonable implementation timelines, and provides a framework for documenting and measuring success and adaptively managing project outcomes.

The plan charts a conceptual course for transforming this degraded urban creek into a watershed that supports improved community assets that improves water quality and fish and wildlife health resulting in enhanced community health and civic pride, increases property values, and provides economic development opportunities as a unique urban ecotourism destination as well as a cultural destination that celebrates local history.

Implementation projects currently in the plan out for comment range in cost from $90,000 to $72 million. These projects include:
Reducing the amount of trash in the watershed,
Removing excess sediment,
Removing sanitary system leaks and illicit discharges,
Removing nuisance and/or exotic species,
Constructing greenways, blueways, stormwater parks, fitness circuits,
Establishing a tidal monitoring system,
Sea level rise and storm surge flood risk education, and
Tidal marsh restoration.

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CHALLENGES AND OPPORTUNITIES TO MANAGING AN URBAN NATURAL AREA: PERSPECTIVES FROM THE UNIVERSITY OF WISCONSIN-MADISON ARBORETUM

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Managing natural areas in urban environments presents multiple challenges. Since 1934, restoration researchers and practitioners at the 485-ha UW-Madison Arboretum have been attempting to restore and conserve tall grass prairie, oak savanna, wetlands and woodlands, most of which lie within a 1,416-ha urban watershed. The Arboretum is heavily fragmented; most noticeably by a six-lane highway that divides 81 ha of remnant and restored prairie and oak savanna from the main property. The urban watershed also contributes, on average, over 1.8 billion liters of stormwater to the Arboretum annually. These high nutrient- and sediment- laden waters have severely degraded many downstream wetlands creating conditions favorable to non-native, invasive cattail and reed canary grass that displace native wetland plants. In addition, the City of Madison's tight prescribed-fire prescriptions and brush-pile-burning ban to reduce smoke pollution severely constrain our ability to manage Arboretum lands. These urban influences along with unintended consequences of some historical management decisions have prompted significant changes in how we manage the land. We actively engage in and promote adaptive restoration in the face of highly modified ecosystems. In recent years we have capitalized on our urban setting by recruiting citizen scientists and partnering with numerous agencies, non-profit groups and neighborhoods to help monitor and manage the land. In light of resource limitations these partnerships have been invaluable to improving our land management and furthering our understanding of the conservation value of the Arboretum. Here we discuss lessons learned from long-term management, monitoring, and adaptive restoration research in an urban landscape.

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EFFECTS OF THREE MANAGEMENT STRATEGIES ON 30 YEAR OLD BOTTOMLAND HARDWOOD RESTORATION SITE

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In the Lower Mississippi Alluvial Valley (LMAV) hydrologic modification and clearing for agriculture since the 1930s have led to over 75% loss of the historic 10 million hectares of bottomland hardwood forest. Efforts to reforest these former agriculture fields have been underway for over 30 years. This often involved planting heavy-seeded species, under the assumption that understory vegetation would return naturally. This has resulted in largely monotypic stands of oak species with closed canopies that inhibit the growth and regeneration of a more diverse mid- and understory. One of the largest afforestation efforts in the LMAV has been at the Ouachita Wildlife Management Area (OWMA), where researchers have been studying and monitoring the bottomlands since restoration began. Previous studies conducted at the OWMA have contributed greatly to the body of ecological knowledge on bottomlands but few have been conducted at spatial scales and with the degree of replication needed to formulate strong conclusions.

Bottomland species have been hypothesized to fall along a continuum of flood-shade tolerance and to be heavily dependent on natural disturbance regimes involving canopy gap formation. Currently, we are evaluating the effects of 2 silvicultural treatments to these oak stands and how they influence habitat heterogeneity. We are also assessing the successional trajectories of 18 fallow and planted research plots spread throughout the 5,000 acre site. We evaluate how these three management strategies (treated, planted, and fallow) compare and what lessons can be learned from patterns observed therein. Our primary goal is to identify economically viable, ecologically sound prescriptions to aid in the future management and restoration of bottomlands across the state and the LMAV.

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ADDING UP THE BENEFITS OF THREE INTEGRATIVE PROGRAMS FOR WATER QUALITY AND HABITAT RESTORATION

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Urban water quality impairments are known for their constancy. Aside from certain discrete problems that can be remediated relatively quickly, most of the impairments stem from the widespread impacts of stormwater pollution. This urban "boundary condition" makes achieving measureable changes in water quality challenging, not to mention significant improvement in biological communities. The legacy of development leaves those who wish to improve conditions with hundreds of miles of roads, hundreds of acres of parking lots, and a housing stock that is largely static in terms of its footprint and land use. In response to these challenges, Washington, DC has developed a suite of programs and policies to reverse the impact of the existing built environment and also to slowly turn back the clock to ecologically healthier streams and rivers.

It is generally assumed that programs to address private property, stormwater regulations, and stream restoration are all part of the solution to address urban water quality problems. What is less frequently discussed is what benefit each of these types of practices can have separately and in concert. Washington DC has the benefit of a small footprint (69 sq. miles) which allows for a closer inspection of the application and efficacy of each of these approaches. Furthermore, DDOE has been implementing some of these programs for several years and, as such, can determine the likely long-term relative impact of these programs over the following decades. By considering the likely impact of each practice and considering the remnant water resources in an urban area, a prioritization system can be devised that will lead to the greatest potential positive impact upon water quality and aquatic communities. The policies and programs that are assessed in this presentation are the RiverSmart Homes program (residential lot retrofit), headwater stream/gully restoration, and improved stormwater retention regulations. Each practices will be described in terms of their past application, their future expected application, and application under special circumstances such as watershed targeting or unique development scenarios. For each of these programs, the expected retetention of stormwater flows will be tallied as well as an expected benefit to local streams and the Chesapeake Bay. By strategically adding up the pieces, urban stormwater professionals may be able to move the needle in terms of both water quality and aquatic resources.

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THE ECOSYSTEM RESPONSE TO RESTORATION: BIRDS AND VEGETATION IN THE COLORADO RIVER DELTA

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The floodplain of the Colorado River in Mexico, covering 12,000 hectares, experienced a recovery in response to inadvertent flows during the 1980s and 1990s. However, the basin has endured a severe drought since 2002, and the average flows been reduced from 93 m^3/s in 1998, to 0.2 m^3/s in the last 5 years. On the other hand, several restoration projects have been implemented in the floodplain since 2008, covering over 200 hectares. To evaluate the effect of the drought on vegetation and birds in the floodplain we conducted variable distance point counts and evaluated habitat characteristics at 136 sites, from 2002 to 2013. We also conducted surveys with the same procedures at 24 sites at the restored areas.

Between 2002 and 2013, the vegetation cover decreased from 76.1% to 60.3% in the floodplain, and the percent cover of trees decreased 53% (from 27.5% to 12.6% cover). Both cottonwoods and willows decreased, 77.1% and 91.6% respectively, with a combined cover of 7.18% in 2002 and of only 0.84% in 2013. The vegetation at the restoration sites in 2013 maintained an overall cover of 77%, with 55% more tree cover (19.8%), and 7 times more cover of cottonwoods and willows than the rest of the floodplain (3.11% and 2.73% respectively). Between 2002 and 2013, the average bird abundance increased 3.8 times and the average species richness remained without significant trend. However, bird diversity per point (N2) decreased 55.8%, while the relative abundance of the 3 dominant species (Red-winged Blackbird, Mourning Dove and White-faced Ibis) increased from 37% in 2002 to 67% in 2013. The community structure changed and species had different responses: 34 species had significant downward trends and 36 species had significant upward trends. Declining species were mostly riparian dependant land birds and breeding waterbirds, including species of conservation priority such as Song Sparrow (90.2% decline), Yellow-billed Cuckoo (100%, no detections in the last two years), Vermillion Flycatcher (66%), and Yellow-breasted Chat (82%). The species with upward trend included birds related to agricultural/urban development, exotic species and raptors, in particular Red-winged Blackbird, Mourning Dove, Yellow-headed Blackbird, Eurasian Collared Dove, and Great-tailed Grackle. In contrast, at the restoration sites, bird abundance was 27.7% higher, species richness was 33% higher, bird diversity was 53.5% higher and the combined density of 12 species of conservation interest was 156 times higher than throughout the floodplain.

The drought resulted in a drastic reduction of flows, causing an important reduction of habitat quality, which in turn was related to a population decline of riparian birds. The efforts at the restoration sites are successfully establishing riparian habitat, with increased populations of species of conservation concern.

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FROM SLIPPERY CONCEPT TO EFFECTIVE TOOLS: DEVELOPING AN OPERATIONAL APPROACH TO RESILIENCE IN ECOSYSTEM MANAGEMENT AND RESTORATION

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Resilience is frequently encountered in policy as a desirable goal for ecosystem management, yet the use of the concept is often vague and it is rarely discussed in ways that make it meaningful on the ground. The demand for science-based frameworks for creating resilient systems is currently ahead of what ecologists can confidently provide. Here we consider which aspects of the multi-faceted concept of resilience can be usefully applied to ecosystem management. We highlight that resilience can maintain both desirable and undesirable states, and hence can be both helpful and unhelpful in a management context.

A big hurdle in the application of the concept to management has been a lack of guidance on how to identify and measure resilience concepts, particularly ecological resilience. We explore species composition, functional diversity and landscape factors as potential measures. All three measures have a role in helping to define management goals (i.e., the desirable state), assessing ecosystem recovery after disturbance, distinguishing between 'unhelpful' and 'helpful' ecological resilience and monitoring the maintenance of helpful ecological resilience. In particular, trait-based approaches offer promise for their ability to link pattern to process across scales and so address a crucial element of the resilience concepts.

Identifying what drives changes in these measures and ultimately the switch between ecosystem states would enable managers to predict the likelihood of a state change and whether intervention would be useful in maintaining or creating a desired state. Lastly, clarifying which drivers (slow and fast) can and cannot be managed to influence these shifts between states could help translate abstract resilience concepts to real-world guidance in management decision-making.

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EXPLORING NATIVE PRAIRIE GRASSES AS COMPETITERS TO SUPPRESS GROWTH OF THE INVASIVE GRASS *SORGHUM HALEPENSE*

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Biological invaders present a major threat to plant diversity; they readily establish in disturbed areas and disrupt restoration efforts by outcompeting and excluding native plants. *Sorghum halapense* (Johnson grass) is a non-native species that threatens wetland meadows, so a solution to its removal is essential for prairie and wetland restoration. Herbicides can destroy rhizomes, but Johnson grass seeds remain in the soil after herbicide treatment. When germinated, these Johnson grass seedlings can compete with any native seedings that would be used to reestablish native habitat. Nevertheless, the effectiveness of native species as competitors with Johnson grass has yet to be explored.

C_3 grasses grow during early spring, so C_3 plants might suppress growth of *S. halapense*. In contrast, NAD-ME C_4 grasses may have a competitive advantage because they fill a similar niche with regard to moisture conditions, but do not require the same high nutrient conditions as *S. halapense*. Finally, native C_4 grasses with the NADP-ME photosynthetic pathway may suppress the growth of *S. halapense* because they fill a similar niche.

This study used two greenhouse experiments to examine the competitive ability of several native prairie grass species against Johnson grass; the first experiment used a controlled moisture and fertilizer regime, while the second one explored two moisture conditions and a lower fertilizer regime. In addition, planting design differed between the two experiments. Nevertheless, in both experiments, several native grass species suppressed growth of Johnson grass as effectively as Johnson grass suppressed its own growth. In both experiments, however, other grass species were poor competitors with Johnson grass. Competitive natives included both C_3 and C_4 grasses, and poor competitors included grasses that used both photosynthetic pathways, as well.

Neither big bluestem (*Androgpogon gerardii*) nor prairie dropseed (*Sporobolus heterolepis*) exerted much competitive pressure on Johnson grass seedlings. Switchgrass (*Panicum virgatum*) showed mixed results across experiments. However, our findings suggest that Virginia wild rye (*Elymus virginicus)*, Indian grass (*Sorghastrum nutans*), and Eastern gamagrass (*Tripsacum dactyloides*) all reduced seed establishment by Johnson grass. Field observations confirm the effectiveness of an *Elymus* species suppressing Johnson grass establishment. Still, Canada wild rye (*Elymus canadensis*) was a poor competitor in our study, suggesting that choice of wild rye species matters. Given Indian grass's rapid maturity and high seed production, it may be a very effective choice for suppressing Johnson grass re-colonization from seed. This may be especially true because both Indian grass and Johnson grass are C_4 grasses that use the NADP-ME photosynthetic pathway. Finally, Eastern gamagrass may be of only limited use in large-scale restoration efforts because of its large seed size and low seed production.

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REDUCING SCIENTIFIC UNCERTAINTY OF GREENHOUSE GAS FLUXES FROM MISSISSIPPI RIVER DELTA WETLAND PROJECTS

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Wetland creation is a primary tool of restoration in coastal Louisiana with approximately $20 billion in Louisiana's Comprehensive Master Plan for a Sustainable Coast projects projected over the next 50 years. Sediment from the Mississippi River increasingly is being used to create wetlands at a landscape scale. Historically a navigation hindrance, these replenishable sediments are being used more broadly than ever. Funding shortfalls, however, will continue to limit the ability to rebuild wetlands at a meaningful rate. Given the tremendous funding challenge, the Louisiana Coastal Protection and Restoration Authority (CPRA) developed a program to evaluate whether revenue generated from wetland carbon offsets could help accelerate the restoration of wetlands and thus avoid the large-scale economic, ecologic, and social consequences of current wetland loss trends. CPRA's carbon program has expanded multiple fronts to strengthen the methodological, economic, and scientific basis for bringing wetland creation projects to the voluntary carbon market.

CPRA developed the *Methodology for Coastal Wetland Creation* for the Verified Carbon Standard, which can accommodate projects in Louisiana and in coastal regions across the U.S. The methodology provides the accounting and monitoring procedures for assessing the carbon benefits of a wetland creation project, including the ability to group projects of similar design and location which can reduce costs of project origination and monitoring. In addition, CPRA has continued to reduce the knowledge gap on wetland greenhouse gas (GHG; methane and nitrous oxide) emissions that can reduce a project's carbon benefit. Using continuous eddy flux measurements, created and mature wetlands have been monitored to provide a landscape-level budget of carbon dioxide and methane flux. These data will be used to advance improvements in GHG predictive models which are critical to reduce monitoring costs, which can be significant. This commitment to robust scientific techniques improves accuracy, strengthens prediction of GHG emissions along the estuary gradient, and can inform decisions on those projects that will provide reasonable returns for CPRA and their partners' investments. This presentation will focus on the recent GHG data collection and analyses.

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COMMUNITY REDEVELOPMENT OF SOCIAL ECOLOGICAL SYSTEMS TO ENHANCE COMMUNITY RESILIENCE USING ECOLOGICAL RESTORATION

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A primary goal of this community redevelopment program is to boost community resilience by enhancing the community's social and ecological system functions among residents and other community members. In this program ecological restoration is featured as a keystone strategy to provide both climate change mitigation and adaptation benefits to reduce the community's disaster risk factors. Thus, in this program "redevelopment" is redefined to include the restoration of a community's social ecological systems, and to reengage community members with the life of the community's land, water and ecological infrastructure.

This community redevelopment program model integrates across multiple disciplines, and translates science into pragmatic strategies based on resilience models, social ecological system frameworks, standards and methods with professional program (project) management methods. The social ecological system framework addresses the interdependent and co-evolving qualities of human ecological relationships; this framework is derived from the empirical work of the Stockholm Resilience Center, the International Union for the Conservation of Nature, Elinor Ostrom's "commons" as a transformative model, and others.

A community that chooses to invest in community agents of change such as youth, families and public employees through community institutions such as schools, libraries, museums and parks, and in community infrastructure such as 100% renewables electrical grids, water system, solid waste management and multi-modal transportation, can apply or adapt all or parts of this community redevelopment program.

Community members identify focal opportunities, then define, fund and implement programs (projects) using a project management approach that adaptively manages against program (or project) metrics. The professional program (project) management leverages the expertise of community professionals such as ecologists, planners, architects, engineers, educators, librarians, and others, and manage within accepted program (or project) management approaches on behalf of the community. The adaptive management process is guided by an iterative, formative evaluation process using methods consistent with the Environmental Evaluation Network, the American Evaluation Association, and others.

The presentation will include specific information on this community redevelopment program, the program (project) management methods, the logic model, the evaluation plan. Specific examples of focal opportunities will include community gardens, schools, libraries, museums, parks, fire stations, city halls and residences. Information will be provided on a newly formed urban ecosystem restoration network.

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SEED ZONES AND PLANT MATERIAL MOVEMENT GUIDELINES IN THE PACIFIC NORTHWEST: PAST, PRESENT AND FUTURE

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The USDA Forest Service (USFS) native plant policy calls for 'genetically appropriate' native plant materials for revegetation of USFS lands. Movement guidelines for these materials have historically been defined by 'seed zones' derived from common garden studies. These seed zones are designed to restrict seed movement to ensure 'locally adapted' materials are deployed in restoration/reforestation/rehabilitation efforts. However, 'local is best' may not be the optimal strategy given the variety and uncertainty of predicted future climate conditions. Consequently, USFS geneticists and others are using the best available science to explore how current strategies might be changed to better adapt to uncertain future climate conditions. This presentation will briefly summarize the history of seed zone delineation in the Pacific Northwest, outline possible modifications of plant movement guidelines in the context of a changing climate, and highlight various climate change and plant materials-related products for land managers. Moreover, this presentation will describe genetic considerations and recommendations that may be incorporated into a plant materials policy to possibly mitigate some of the effects of predicted climate change scenarios.

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RESTORATION PLANNING EFFORTS IN THE MIDDLE MISSISSIPPI RIVER – FROM THE MOUTH OF THE MISSOURI RIVER TO THE OHIO RIVER

Brian. L. Johnson *Presented by:* ***Marvin Hubbell***
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The Middle Mississippi River (MMR) is that portion of the Mississippi River located between the confluences of the Missouri and Ohio rivers. This section of the river represents a transitional shift in a number of ways including geography, river complexion, and management of the river and its floodplain. The MMR represents the shift from a river managed through a series of pools created by locks and dams to one managed entirely by dredging and river training structures. Isolated floodplains and mainline levees are more prevalent in the MMR. The reach also encompasses the northern end of the Mississippi Alluvial Valley. Restoration needs within the MMR reflect this complex matrix. Efforts are focused on a number of key habitats including bottomland and riverfront forest, bottomland prairie, side channels, and bottomland lakes.

In the late 2000's, the Middle Mississippi River Partnership (MMRP), in association with the Corps of Engineers, completed a multi-year collaborative planning study in the MMR. The development of usable ecosystem restoration planning and preservation tools was a central focus of the study. Towards that end, a hydrogeomorphic (HGM) based planning tool was created for the basin. The heart of the HGM tool was the use of data on geomorphology, soils, topography, and hydrology to document pre-settlement and existing ecosystem conditions, and to help develop appropriate and realistic restoration objectives for the basin. The completed HGM report, and the corresponding GIS data layers, are being used by MMR stakeholders to target and prioritize restoration opportunities. In addition, the MMRP prepared detailed reach reports for the basin which identified site-specific restoration needs and opportunities for five reaches within in MMR. Together these tools have been used to drive and focus restoration planning within the watershed.

Restoration efforts within the basin have focused on multiple scales. Large-scale restoration and preservation efforts have largely been lead by federal and state agencies, including the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Forest Service, the Missouri Department of Conservation, and the Illinois Department of Natural Resources. A number of equally important smaller-scale efforts are being undertaken by a partnership of agencies and non-governmental organizations. Many of these efforts have been developed or furthered using the HGM and reach report tools.

Successful long term restoration within the MMR will continue to require a mosaic of federal, state, local and private programs, authorities, funds, and grants. The existing model includes projects funded with mitigation dollars, conservation and wetland reserve funds, land acquisition funds, conservation grants, ecosystem restoration program dollars, endangered species funding, and other programs and funds.

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RESTORATION OF THE UPPER MISSISSIPPI RIVER: ST. PAUL TO ST. LOUIS

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When the Upper Mississippi River Restoration Program (UMRR) was authorized in 1986, it became the first comprehensive large river ecosystem restoration program in the United States. Not only did the UMRR pioneer work on larger river systems, it was truly unique in that it combined the ability to design and construct large and small scale river rehabilitation projects with the ability to monitor and research key environmental attributes of the UMRS. Both Program elements have increased our understanding of the river and help guide refinement in restoration techniques.

The UMRR Program is celebrating 28 years of serving the Upper Mississippi River System (UMRS). During that time, the Program has restored approximately 100,700 acres of critical habitat through the completion of 55 habitat rehabilitation projects. In addition, the Program has collected data on key environmental attributes of the river in six key pools within the 1,200 miles of river served by the program. These data document both the annual and long term trends occurring within the UMRS. The foundation of this highly successful Program has been its active and diverse partnership, which is made up of five federal agencies, five states, numerous Non-Governmental Agencies (NGO's), and an active public. These partners contribute to a high degree of diversity in terms of technical expertise, river related duties, policy interest, and financial capability. Partnership contributions to the UMRR have been invaluable. The collective efforts of the Partnership have been to sustain this comprehensive Program for 28 years; this has contributed nearly $500,000,000 to restoration and scientific efforts in the five state region of Missouri, Illinois, Iowa, Wisconsin, and Minnesota during this period. In addition, state and federal partners have contributed more than $32,000,000 in support of the Program in terms of direct cost share on rehabilitation projects and contributed labor through their participation on a wide variety of advisory teams.

This presentation will highlight some of the key efforts and future direction of the Program. The vision of the Program is to continue to focus the restoration and scientific work being done along the river to increase the resiliency and health of the UMRS.

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CONSIDERATIONS FOR RESTORATION OF HEAVILY INDUSTRIALIZED RIVERS IN THE UNITED STATES: A CASE STUDY OF THE LOWER PASSAIC RIVER IN THE NEW YORK/NEWJERSEY (NY/NJ) HARBOR ESTUARY

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The estuarine portion of the Passaic River in northern New Jersey (a tributary to Newark Bay and part of the larger NY/NJ Harbor Estuary) is the subject of an ongoing multi-agency restoration initiative under the Water Resources Development Act (WRDA) and Superfund entitled the Lower Passaic River Restoration Project (LPRRP). As part of this initiative, multi-stressor impacts to the River are being assessed in the context of risks to humans and fish/wildlife, and potential restoration options are being evaluated to mitigate at least some of the effects of more than two centuries of urbanization and industrialization of the River that have had severe consequences on the ecology of the system.
The post-Columbian history of the lower Passaic River is one of industry and urban development. For more than 250 years, the River and its shorelines have been physically altered, habitats have been destroyed or severely degraded, and the River has been used as a receptor for sewage and industrial/municipal point- and non point-source pollutants, many of which now reside in buried and, to a lesser extent, surface sediments. Biological production in the River reached a low point at the turn of the 20th century. Since that time, the active industry along the River has decreased, sewage systems have been enhanced, and water/sediment quality have improved to a degree—yet the urbanized nature of the River remains. The future of the lower Passaic River is an urban ecosystem that will include a balance of human industrial and recreational use of the River, along with an ecosystem made up of a mosaic of relatively small estuarine and freshwater habitat parcels interspersed within largely developed shorelines, cities and townships.

The process of quantifying ecological services losses and selecting appropriate restoration is often reliant on the application of value judgments and broad assumptions regarding what is a normally functioning ecosystem relative to a set of baseline conditions. This is particularly true in urban ecosystems like the lower Passaic where: 1) only anecdotal information is available regarding the historical ecology of the system, 2) the habitats have been fragmented, changed, and impacted by multiple stressors for centuries; and, 3) biodiversity and sustainable ecological function are the restoration targets, as opposed to restoration to an often unknown or unattainable historical baseline. The list of potential restoration alternatives for an urban river such as the Passaic can be large and diverse, with specific projects on the list typically reflecting the value judgments of a variety of scientists, regulators, and stakeholders. This presentation will focus on these issues and their broader context for management and restoration of urban waterways.

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REINTRODUCTION OF ANADROMOUS SALMONIDS ABOVE SHASTA DAM: OPPORTUNITIES AND CHALLENGES

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Anadromous salmonids have been blocked from approximately 80 percent of their historic spawning and rearing habitat in California's Central Valley rivers and have not accessed the habitat above Shasta Dam for over 70 years. Shasta Dam is a principal feature of the U.S. Bureau of Reclamation's (Reclamation) Central Valley Project (CVP). The CVP plays a key role in California's economy and is one of the Nation`s major water conservation developments. In 2008, the National Marine Fisheries Service (NMFS) issued a jeopardy Biological Opinion (BO) on the Long-term Coordinated Operation of the CVP and State Water Project. The BO's reasonable and prudent alternative, as well as the recommendations in the Draft Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead, identified the need to reintroduce these fish into their historic habitat above the CVP dams.

The Shasta Dam Fish Passage Evaluation is an effort to evaluate the feasibility of reintroducing Chinook salmon and steelhead to tributaries above Shasta Lake. A Fish Passage Pilot Implementation Plan is being developed by representatives from Reclamation, NMFS, U.S. Fish and Wildlife Service, U.S. Forest Service, California Department of Water Resources, California Department of Fish and Wildlife, State of California Water Resources Control Board, and the University of California, Davis.

The plan will identify biological, management, and engineering evaluations designed to determine the feasibility of reintroducing anadromous salmonids through a long-term fish passage program. Actions will include experimental capture, transport, and release of adult and juvenile Chinook salmon and evaluation of life-stage specific survival rates. Key challenges facing the implementation of the pilot study include: (1) landowner acceptance and cooperation; (2) Endangered Species Act compliance, permits and rules to authorize pilot-level and long-term reintroductions; (3) state and federal regulatory requirements; (4) design of collection facilities to provide for juvenile passage; and (5) public concerns about the interaction between reintroduced Chinook salmon and the world-class wild trout fishery. The plan will provide an assessment strategy and protocols for investigation of critical biological performance criteria and fish passage engineering options to evaluate the potential for success of re-establishing a viable population of Sacramento River winter-run Chinook salmon upstream from Shasta Dam.

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ECOSYSTEM SERVICES VALUE AT RISK: TOWARDS MARINE ECOSYSTEM RESTORATION

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A conceptual framework is developed for a novel ecological economics risk measure that we call "ecosystem services value at risk," integrating ecosystem services valuation with financial value at risk to provide an estimate of a "worst likely loss" in benefits from nature under alternative policies. This new approach quantifies the uncertainty around ecosystem services values from human activities. By framing the risk to ecosystem services in terms of extreme loss, a more powerful message is sent about the need to protect natural ecosystems.

This new approach is illustrated with an application of a stochastic Schaefer surplus production model to a case study of the collapsed Georges Bank yellowtail flounder. This marine example is timely and critical; marine ecosystems, which provide many valuable and essential benefits to humankind, are being severely altered all over the world from overfishing, climate change, marine pollution and habitat destruction. The core elements of an ecosystem services value at risk framework include ecosystem services valuation; total economic value; stochastic ecological models; financial value at risk; intergenerational discounting; a long time frame for evaluation; and decision rules. This research is multidisciplinary, drawing insights from ecological economics, finance, fisheries economics, ecological modeling and decision analysis.

A simple risk measure based only on the market values of provisioning services from catch is first demonstrated; later, the nonmarket values of a second type of ecosystem service, the regulating services from conserved biomass, are considered. Both values taken together provide a basis for a lower bound estimate of the ecosystem services value at risk for the marine ecosystem. Simulation of the ecosystem services value at risk measure based on catch alone leads to selecting conservative harvest policies and rules out high levels of fishing intensity. Including regulating services allows even more precautionary strategies that favor conservation.
The ecosystem services value at risk framework is thus supportive of sustainability, providing for rebuilding collapsed marine resources for the benefit of current and future generations.

The ecosystem services value at risk approach is expected to be useful in protecting marine ecosystems and to further the use of ecosystem services valuation in marine policy evaluation. Integration of this new approach into fisheries stock assessment and management advice promises to foster efforts towards marine ecosystem restoration and ecosystem resilience.

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SABINE REFUGE MARSH CREATION (GULF COAST, LOUISIANA)

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Most of the navigable waterways in Louisiana require dredging at varying intervals to maintain suitable depths for maritime traffic. Currently the U.S. Army Corps of Engineers dredges approximately 67 million cubic yards (CY) of material in Federal navigable waterways within the boundaries of the New Orleans district. However, only around half of the annual average total of maintenance dredging (33 M CY) is suitable for beneficial use. Of that amount about 16.5 M CY is used by the USACE for beneficial use. One such Federal navigation channel where beneficial use has been occurring with assistance from other Federal and state programs is along the Calcasieu River Ship Channel (CRSC).

The Sabine Refuge Marsh Creation project is located in the northwestern portion of Sabine NWR in Cameron Parish, Louisiana. The project located north of Brown's Lake just west of the CRSC contains large open water areas. The project area has suffered severe marsh degradation due to saltwater intrusion and freshwater loss. This has resulted in the conversion of vegetated intermediate to brackish marsh and shallow open water areas. Salinity migrates into the region from the Calcasieu River when southerly winds push saline waters into the project area through existing canals and bayous. In 1999 the Louisiana Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) program dedicated 5 coastal wetland restoration projects (or cycles) in this area, using dredged material from the federally authorized CRSC.

The first cycle constructed approximately 214 acres of marsh within the shallow open waters of the Sabine Refuge in 2002. The second cycle constructed a 3.6 mile long permanent buried pipeline extending from the western reach of the CRSC to the northern marshes of Sabine Refuge. This pipeline will be utilized starting with Cycles 4 & 5. The Cycle 3 marsh creation was constructed by the Louisiana Coastal Protection and Restoration Authority using Coastal Impact Assistance Program funding, and resulted in the creation of 204 acres of marsh. Cycles 4 and 5 are scheduled to be constructed in 2014 and will result in the creation of approximately 460 acres via dedicated dredging and beneficial use of the CRSC material through the permanent pipeline.

The implications of beneficially using dredge material to create marsh along the Louisiana coast is vastly important, because internally borrowing sediment for marsh creation leaves the overall system with a sediment deficiency. The CWPPRA program's Sabine Refuge Marsh Creation project can be used as an example for the beneficial use of dredge material in coastal Louisiana.

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CHALLENGES IN PLANNING URBAN STREAM RESTORATION PROJECTS

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Restoration of urban streams presents well-documented technical challenges including: complicated hydrology resulting from stormwater runoff and a high percentage of impervious surfaces, space constraints due to infrastructure and utilities, complicated property boundaries, human debris littering the project sites, abundant invasive species, and financial constraints. Project managers face additional challenges associated with the human dimensions of urban stream restoration. Project design in urban settings should be guided by a fundamental understanding of the operating constraints that may preclude success (Bernhardt and Palmer, Freshwater Biology, 2007). Sharing challenges in urban stream restoration will facilitate a greater understanding of these constraints and allow them to be addressed early in the planning process to help ensure successful project implementation.

Public participation and perception of urban stream restoration projects can be the key to success or failure of a project. Early public involvement can be the key to success because urban stream restoration projects are often partially or entirely on private land. In many urban rivers and streams, the principal benefits from a restoration project are social, such as building a sense of community by involving residents of a neighborhood or increasing pride of place (Wohl et al., Water Resources Research, 2005). It is important to understand the current use of the stream on private property and design accordingly. For example, incorporating features such as stream crossings and paths through newly planted riparian vegetation for fishing or swimming access can ensure that the project will remain intact.

Re-establishing the riparian buffer is an essential step towards restoration and often requires cooperation from property owners. Understanding the property owner's expectations for the riparian environment on their property can be important in establishing and maintaining a quality riparian buffer with attractive native species. Conservation easements should be put in place in conjunction with a stream restoration project. Negotiation with property owners can take a long time, but it is time well spent, as one person can stop a project from being built.

Close coordination with municipal, county, state, and Federal agencies, as well as sewer and utility companies, is imperative. Utility lines often run along or across streams and it is often difficult to obtain a good record of crossing locations. Although the primary focus is in avoiding any impacts to these utilities, the stream restoration project may provide an opportunity to discuss relocation or replacement.

There are many challenges in urban stream restoration and an open discussion including practical solutions will lead to more successful projects. Lessons learned from these challenges are applicable to other types of restoration and local, state, and federal restoration practitioners.

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OYSTER REEF RESTORATION: RESTORING ECOLOGICAL FUNCTION

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Halfmoon Reef was the largest oyster reef in Matagorda Bay, Texas, in 1905, covering over 490 acres of bay bottom, extending nearly 4 miles, and rising 4-5 feet above the bottom. Maps from 1839 showed the reef and bathymetric surveys documented its existence until the mid-1930's. Matagorda Bay has undergone a number of hydrological modifications and has experienced a variety of impacts over the intervening years while Halfmoon Reef has ceased to exist.

The Nature Conservancy in Texas envisioned restoration of Halfmoon Reef. A key feature of the The Nature Conservancy's vision was to build a reef with a substantial vertical component. Atkins was hired to help design and manage construction of the reef. The design process addressed: 1) Resource agency concerns about relatively high salinities and possible Dermo infections; 2) Substrate selection; 3) Maximizing habitat variability; and 4) Ensuring long-term reef stability. The project was permitted under Nationwide 27, Aquatic Habitat Restoration, Establishment, and Enhancement, permit. The long-term goal of the project is to return ecological functions to the bay formerly provided by the oyster reef over 100 years ago.

Construction of the first phase of Halfmoon Reef, funded by the Coastal Impact Assessment Program, was managed by Atkins and completed in December 2013. Construction is poised to begin on the adjacent, second phase of the project. Combined, the two projects will create a reef complex covering 54 acres. The second phase of the project will be managed by the U.S. Army Corps of Engineers and funded by the Corps and The Nature Conservancy's private donors. The reef complex consists of parallel rows of substrate, 650 feet long, 18 feet wide, and 3 feet high at the crest. The distance between row centers varies in an alternating pattern between 30, 60, and 90 feet. Substrate size ranges from 6 inches to nearly 3 feet. The first phase of the project was constructed with limestone and the second phase of the project will be constructed with recycled, clean, concrete. Post-construction monitoring of the constructed reef will assess biological utilization of the reef over a period of five years.

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AN EVIDENCE-BASED EVALUATION OF THE CUMULATIVE EFFECTS OF ECOSYSTEM RESTORATION IN THE LOWER COLUMBIA RIVER AND ESTUARY

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The listing of 13 salmon and steelhead stocks in the Columbia River basin (hereafter collectively referred to as "salmon") under the Endangered Species Act has stimulated tidal wetland restoration in the lower 235 kilometers of the Columbia River and estuary for juvenile salmon-habitat functions. The purpose of the research reported herein was to evaluate the effect on listed salmon of the restoration effort currently being conducted under the auspices of the federal Columbia Estuary Ecosystem Restoration Program (CEERP).

We designed an evidence-based approach to develop, synthesize, and evaluate information to determine early-stage (~10 years) outcomes of the CEERP. The primary hypothesis was that habitat restoration activities in the LCRE have a cumulative beneficial effect on juvenile salmon. There were two necessary conditions of the hypothesis: 1) habitat-based indicators of ecosystem controlling factors, processes, and structures show positive effects from restoration actions, and 2) fish-based indicators of ecosystem processes and functions show positive effects from restoration actions and habitats undergoing restoration. We identified a set of 12 ancillary hypotheses regarding habitat and salmon response. Each ancillary hypothesis states that the response metric will trend toward conditions at relatively undisturbed reference sites.

Our evidence-based approach to evaluate the primary hypothesis incorporated seven lines of evidence: spatial and temporal synergies, cumulative net ecosystem improvement, estuary-wide meta-analysis, offsite benefits to juvenile salmon, landscape condition evaluation, and evidence-based scoring of global literature. We synthesized the evidence for and against the two necessary conditions by using eleven causal criteria (e.g., strength, consistency, temporality, and analogy). Our final evaluation included cumulative effects assessment because restoration is occurring at multiple sites and the collective effect is important to salmon recovery.

We concluded that all five lines of evidence from the LCRE indicated positive habitat-based and fish-based responses to the restoration performed under the CEERP, although tide-gate replacements on small sloughs were an exception. Our analyses suggested that hydrologic reconnections restore access for fish to move into a site to find prey produced there. Reconnections also restore the potential for the flux of prey from the site to the main-stem river, where our data show that they are consumed by salmon. Several data sets illustrated nonlinear, synergistic, and/or pulsed characteristics of hydrologic reconnection, suggesting that the cumulative effects of restoration are complex in space and time. In general, though, tidal wetlands in the LCRE support juvenile salmon, including interior basin salmon. The beneficial effect of restoring tidal wetlands is expected to increase over time as existing restoration projects mature and new ones are implemented.

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4-YEAR ECOLOGICAL ASSESSMENT OF THE BALLONA WETLANDS TO INFORM RESTORATION PLANNING

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Coastal wetlands are unique transitional areas containing diverse groups of organisms idiosyncratically adapted to living in this highly dynamic interface between fresh and salt water. In southern California, anthropogenic stressors and impacts have significantly modified many of these coastal wetland systems; in some cases, such as the 600-acre Ballona Wetlands Ecological Reserve (BWER), many ecosystem functions have been lost primarily due to hydrologic modifications and development over time.

The Ballona Wetlands Monitoring Program has completed four years of biological, physical, and chemical pre-restoration baseline assessments. We analyzed the condition of the many habitats found throughout the site by evaluating multiple ecological factors in each habitat type. For example, the California Rapid Assessment Method was applied in all salt marsh habitat types, with comparisons to regional data. Benthic taxa and water quality assessments within the tidal channels helped identify anthropogenic stressors to the estuary, and gauged the potential to support other trophic levels. Additionally, vegetation associations mapped over time, combined with higher-intensity transect-level cover data, provided data on species invasions and the overall nativity of each area within the site.

Overall, the muted effects of the tide gates and severely altered hydrology and topography have reduced the salt marsh habitat availability and quality on site, and have significantly modified the ecological community. Some areas have retained functions such as providing nesting habitat for species of concern, e.g. the Belding's Savannah Sparrow, while others suffer from high degrees of invasion by habitat-altering plants such as *Euphorbia terracina* and *Cortaderia selloana*. The results of these analyses, combined with historical site information and climate change adaptation planning have informed adaptive restoration recommendations and management actions for the BWER.

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HYDROLOGIC RESPONSE OF HILLSLOPE SEEPS AND HEADWATER STREAMS OF THE FORT WORTH PRAIRIE

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Hydrologic features, such as seeps and headwater streams, are important components within many landscapes and provide several ecosystem values and services. Although it is presumed that hydrologic regimes significantly affect the biologic structure and composition of riparian areas, relatively little research has been conducted on the spatio-temporal relationships among vegetation, topography, and hydrology along seeps and headwater streams found in the north central region of Texas. In Texas, over 75% of the streams are ephemeral or intermittent in nature and these features will become increasingly important in the Dallas-Fort Worth metroplex due to urban development and the expected population explosion. To ensure a clean and available water supply to the growing population of this region, small headwater streams along the Trinity River would need to be maintained and restored, thus understanding the nature of seeps and headwater streams can be useful for local riparian restoration in Fort Worth.

The Fort Worth Prairie, an open grassland unit that extends between the Eastern and Western Cross Timber ecoregions and bounded to the north by the Red River and to the south by the Brazoz River, is a unique part of an endangered ecosystem: the tallgrass prairie. Today, only a fraction of the prairie remains intact. The vegetation is mainly grasslands, which form over alternating layers of erosion-resistant limestone and soft marl. These two types of bedrock create gently sloping valleys and narrow ravines. However, unlike the classic tallgrass prairies described in the Midwest, these riparian zones are often dominated by annuals. Due to the ephemeral or intermittent nature of headwater stream hydrology, the high variation of soil moisture restricts tallgrasses from dominating riparian headwaters.

This study quantified the hydrologic regime of a Fort Worth Prairie hillslope hollow, by analyzing the temporal and spatial soil moisture response to precipitation and drying, its impact on runoff generation, and the vegetation-soil moisture relationship. The study occurred from August 2012 - March 2013, during drought-like conditions that prevented streamflow. Results show the hillslope completely saturates during wet periods and during dry conditions saturation is most extensive along the hillslope base. Autumn vegetation most accurately aligns with moderate soil moisture conditions. This research describes Fort Worth Prairie headwater stream and seep habitats and provides a basis for how they function hydrologically in order to create a foundation for improved habitat management, protection, and restoration of riparian headwaters in North Central Texas.

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COGONGRASS INVASION OF THE SOUTHEASTERN FORESTS: IMPACTS ON RESOURCE AVAILABILITY, SPECIES DIVERSITY AND PRODUCTIVITY

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Cogongrass (*Imperata cylindrica* (L.) Beauv.), a perennial grass native to southeast Asia, has become one of the most notorious exotic pests in the southeastern U.S. The forestlands in the Southeast are being occupied by this non-indigenous species at an alarming rate threatening their ecological integrity. Field and greenhouse trials have demonstrated that cogongrass can decrease species diversity, alter soil physico-chemical and microbial properties, and decrease productivity of natural and planted pine forests of the South. Based on data collected from multiple trials over the past 15 years, this presentation will explore the mechanisms by which cogongrass gains dominance over native species and its subsequent ecological impacts to the structure and function of invaded ecosystems.

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IMPORTANT SYMBIONTS OF SPARTINA ALTERNIFLORA ARE SENSITIVE TO RESTORATION STATUS

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Plant performance and wetland function can strongly correspond to microbiome community structure. Consequently, environmental alterations that influence microbiome community structure may result in a cascade of changes in plant productivity, food webs, and ecosystem function. In turn, microbial shifts could promote responses to environmental shifts that result in remediation, resilience, and recovery of degraded ecosystems. In this study we used a culture-dependent approach, combined with molecular data, to determine whether restoration status influenced diversity and composition in Spartina alterniflora's leaf fungal endophyte communities – fungi that live within plant tissue without causing apparent harm to the host. We collected healthy plants from three habitat types (restored, natural, and degraded) at two sites (Big Branch National Wildlife Refuge and Fourchon) in southeast Louisiana. We surface sterilized the leaves and isolated the fungi growing within the leaf tissue. We extracted total genomic DNA from each fungal culture and amplified and sequenced a ca. 1000 basepair region of the nuclear ribosomal repeat (internal transcribed spacers and 5.8S and 28S gene) to determine endophyte diversity and composition. Endophyte diversity was significantly higher in plants from natural marshes, but those from restored and degraded did not differ. Furthermore, endophyte composition differed among the three habitat types, with natural and restored marshes being most dissimilar, demonstrating that environmental conditions influence endophyte composition. Future research should focus on the consequences of such shifts in endophyte communities on plant populations and ecosystem services, especially in the context of natural and anthropogenic disturbances, such as hurricanes and oil spills respectively.

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GROUND FIRE EFFECTS AND IMPLICATIONS FOR FIRE MANAGEMENT

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Smoldering ground fires in organic-rich soils have several obvious negative effects including air quality and motorist safety, as well as broad-scale implications resulting from their release of large quantities of stored carbon. However, the ecological implications of the frequency and intensity of organic soil combustion occurrence are relatively unexplored. Smoldering fires in organic soils may increase local hydroperiod and wetland storage by lowering elevation, conferring benefits to wildlife (e.g., dry season refugia and feeding grounds). Short-term increases in productivity due to nutrient availability from ash may occur in or adjacent to areas affected by ground fires. Short-term negative feedbacks to fire return period are also likely to occur locally, due to increased hydroperiods; however, adjacent uplands may experience hydrologic changes as well, including factors which may affect fire risk far from areas of organic soil consumption. To explore hydrologic implications of soil-consuming ground fires, we developed a model based on a low-relief region in southern Florida (U.S.A.) that is characterized by seasonal hydrologic fluctuations and areas of organic soil distributed across a landscape that experiences frequent fire (i.e., 2-4 year return interval in uplands adjacent to wetlands). Parameterizing the model with local soil and hydrologic properties, as well as observed effects of fire in the region's organic soils, the model predicts changes to wetland depths, bathymetry, and storage competence as a function of fire severity (i.e., area and depth of burn) that may be ecologically significant. Our findings imply that soil-consuming ground fires—and their prevention—have ecohydrological implications that must be considered when developing ecosystem and fire management protocols.

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PHYSICAL HYDRAULIC MODELING TOOLS FOR RESTORATION OF ENDANGERED SOUTHERN STEELHEAD HABITAT

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A primary goal of the National Marine Fisheries Service Southern California Steelhead Recovery Plan is to stabilize and eventually restore steelhead trout numbers in coastal streams from the Santa Maria River in Santa Barbara County south to the United States and Mexico border. It is estimated this Southern California distinct population segment of steelhead once numbered over 45,000 but has since declined to less than 500 and was listed as endangered under the Endangered Species Act (ESA) in 1997. The ESA requires a Recovery Plan be developed when a species is listed under the statute as either threatened or endangered.

The development of a Recovery Plan is an important part in the successful rebuilding of a species because it incorporates information from a multitude of interested parties including scientific researchers, stakeholders and the general public. NOAA Fisheries Service spent over ten years developing a scientific foundation for the Recovery Plan, and over two years gathering information during a series of workshops and meetings with the public from Santa Barbara to Carlsbad, California.

The San Juan and Trabuco Creek Watershed, located in south Orange County, CA has been targeted by NMFS as a prime watershed for steelhead recovery. There are relatively few barriers to reestablishing a steelhead population in this river system. Chief among physical barriers to steelhead migration are two structures located at the Metrolink Rail and Interstate 5 crossings of Trabuco Creek. Two physical models at a 1:20 scale and a 1:6 scale are being used to test fish passage over a number of flows. The results of the physical model testing will inform the ultimate design of the Fishway. Specific objectives include refinement of the proposed cascade and pool design sequence, meeting fish passage requirements, evaluation of the stream's sediment regime to ensure erosion and/or deposition will not prevent fish passage at crucial times, determining rock sizing for the rock weirs and engineered streambed materials required for stability up to the 100-year flood discharge (or 13,700 cfs), and to provide a hands-on demonstration of the design concept to facilitate mutual understanding of the design, prior to construction. Live video footage, photography, and reporting will be featured as part of this presentation. The stream restoration improvements, inclusive of the Fishway will provide channel stability and habitat for multiple species, improve water quality, reduce property loss, and provide safe trail crossing for equestrians.

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ECOLOGICAL AND ADMINISTRATIVE CONSTRAINTS TO RESTORING COASTAL HABITATS ALONG JAMAICA BAY, NYC

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The historic Shore Parkway section of the NYC Belt Parkway travels 16 miles from the East River, along the southern shoreline of Brooklyn, to JFK International Airport. This scenic drive had open views to the waters of Jamaica Bay, parallel systems of bicycle and pedestrian paths, and connections to a group of adjacent parks. Over time the views have become obscured, pathways have fallen into disrepair, and park connections made impassable due high volume, fast moving traffic. Reconstruction of the Parkway bridges presents an opportunity for landscape restoration, but is constrained by both ecological and administrative factors.

Site assessment revealed maritime plant communities degraded by many non-native invasive vines, Phragmites reeds, and trees. The degraded plant communities follow a typical elevational gradient of low-lying beach and salt marsh plants bordering Jamaica Bay, transitioning to salt tolerant shrubs, then maritime forest. Construction activities removed plants primarily from the forest zone. Soil analysis revealed wide-ranging pH reflecting the sandy dredge soil base, past and present construction dumping, and high pH topsoil applied in medians and road banks where turf grass was then sown. The impact of Hurricane Sandy here in October 2012 is obvious, with debris fields, vegetation death and uprooting. Targeted invasive and hurricane debris removals and re-planting of coastal species in all zones will most effectively enhance site-wide ecological health and add resiliency to predicted increases in storm frequency and significant sea level rise. Implementation of these ecological recommendations is constrained by funding levels for invasive plant removal, concerns about maintenance needs, and different public agencies having regulatory control of adjacent parcels. Ecological restoration will require close collaboration among these municipal and federal agencies.

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RESTORING WET PINE SAVANNAH IMPACTED BY DITCH CONSTRUCTION IN HANCOCK COUNTY, MISSISSIPPI, USA

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Wet pine savannahs in coastal Mississippi are under constant pressure by developers due to their proximity to the Gulf of Mexico and its associated commercial and recreational amenities. A developer acquired a large parcel of land in Hancock County, Mississippi to construct a business and residential community. Wet pine savannah ecosystems occupied a significant portion of this land. In an effort to modify site hydrology to make it suitable for such development, the owners excavated several miles of large ditches through the wetlands without appropriate permission. A member of the Gulf Restoration Network living adjacent to the intended development began to experience severe flooding never before seen on their property. Following complaints, the US Army Corps of Engineers Mobile District and the Environmental Protection Agency Region 4 became involved. A lawsuit was filed by the Gulf Restoration Network on behalf of their member to halt the illegal activities and seek compensation for damages incurred. As a result, the developer was ordered to restore the impacted wetlands and to donate a portion of their land to the Land Trust for the Mississippi Coastal Plain to hold as conservation.

Approximately 37 acres of land were directly impacted by the ditch excavations. More than 26,000 cubic yards of dirt were moved to fill the ditches and bring these areas back to the appropriate elevation. The site was then allowed to naturally recruit plant species characteristic of native wet pine savannahs in coastal Mississippi. Bare-root nursery trees were planted to insure canopy diversity. Monitoring and maintenance to control exotic species are ongoing. The site is in its first year since completion of the earthwork. The history of the site, restoration activities and methods, and current site condition are discussed.

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NURSERY PRODUCTION OF HIGH QUALITY ASPEN SEEDLINGS: ALTERNATIVE TECHNIQUES IN THE FOREST RECLAMATION AND RESTORATION PROCESS

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Developing high quality seedlings for reclamation and restoration activities is becoming an important component of the forest reclamation and restoration process (Hobbs and Norton 1996; Puttonen 1997; Brown and Amacher 1999; Suding 2011). This is particularly true when confronted with novel landscapes that have been heavily altered through resource extraction or other disturbances. In such cases, the use of high quality seedlings in the reclamation process can often increase seedling survival and may promote more rapid forest establishment (Colombo 2003). Thus, identifying nursery practices which increase seedling quality is quickly becoming a focal point in the overall reclamation and restoration process.

There is growing interest in the use of quaking aspen (*Populus tremuloides*) in boreal forest reclamation, as it is a fast growing species native to the area. However, there is limited information available on the characteristics of aspen seedlings which best promote outplanting success (Pinno *et al.* 2012; Landhäusser *et al.* 2012). Initial measures of aspen seedling quality were similar to those devised for conifers (Navarro *et al.* 2006) with height, root collar diameter and terminal bud size being the primary estimators of the quality of planting stock. However for aspen, as for many other hardwood seedlings, these parameters provide limited support towards outplanting success (Landhäusser *et al.* 2012). Rather, the characteristics of greater importance for successful outplanting of aspen seedlings include a high root total non-structural carbohydrate (NSC) concentration and a high root to shoot ratio (Landhäusser *et al.* 2011).

In the experiment presented here, we artificially adjusted the light environment in order to determine how light quantity and quality could be used to manipulate the balance between seedling growth and storage. Particularly, our objective was towards identifying the light environment under which aspen seedlings allocate a greater proportion of carbon to roots and root reserves. However, our results displayed limited evidence for a clear effect of either light quantity or quantity on the balance between seedling growth and storage. Suggested reserve status of aspen seedlings, for successful outplanting in a reclamation setting, are for a root to shoot ratio greater than 2 and root NSC of greater than ~30% (Landhäusser *et al.* 2012). These suggested benchmarks were most closely reached by seedlings grown under unsheltered full-sun conditions. In all other cases the root to shoot ratio was only half of that provided as a benchmark and the root NSC concentration just three quarters of what is recommended for successful outplanting in a reclamation setting. Thus alternative or complementary techniques, such as the use of growth inhibitors (Landhäusser *et al.* 2012), withholding of water (Sala *et al.* 2010) or the use of supplementary CO_2 (Way *et al.* 2007), particularly near the end of the growing season, may play a more beneficial role in the development of high quality seedlings than alteration of the light environment alone.

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REPORT CARD SUPPORTS INTEGRATED MANAGEMENT IN THE MISSISSIPPI RIVER BASIN

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Creating a report card for the Mississippi River basin has helped focus efforts to implement integrated river basin management in the region. The America's Watershed Initiative (AWI) kicked off in September 2012 with a summit held in St. Louis, Missouri. AWI brings together a wide range of stakeholders, from industry, agriculture, transportation, and environment, with the overall objective to develop common management, communications, and assessment frameworks for the Mississippi River Basin. At the summit, stakeholders articulated six goals to guide integrated management of the basin: Maintain supply of abundant clean water; Mitigate risk and provide reliable protection from flooding; Support local state and national economies; Nurture healthy and productive ecosystems; Create world-class recreation opportunities; Serve as the nation's marine water highway.

Creation of a basin-wide report card stimulated communication among stakeholder groups through their assistance in assembling and integrating information related to each of the six goals. The Mississippi River basin report card represents a substantial evolution in the application of environmental report cards. Report cards developed previously, such as the Chesapeake Bay report card, focused on assessing the health of the natural environment. The framework developed for the Mississippi River basin report card aims to assess the status both of key elements of the natural ecosystem as well as the human-built systems. Following the AWI summit, we conducted a series of six workshops to engage groups with regional expertise. Experts provide input on goals, values, desired conditions, and indicators related to the six goals. The AWI steering committee has guided selection of the set of indicators to include in the report card. Our goal is to present a completed report card at the next AWI summit scheduled for the end of September 2014. In addition to providing an easy-to-grasp assessment of conditions in the watershed, the process of developing the report card helped to broadened perspectives, encouraged dialogue, and promoted collaboration among different stakeholder groups through their participation in the workshops.

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EVERGLADES CONNECTIVITY THROUGH THE EYES OF THE SOUTH FLORIDA ESTUARIES

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A primary goal of the Comprehensive Everglades Restoration Plan (CERP) is to restore more natural hydrologic conditions to the wetlands and estuaries of South Florida. For the estuaries, this means restoring the quantity, timing and distribution of freshwater that is delivered to Florida Bay, Biscayne Bay and the Southwest Coast estuaries. The Southern Coastal Systems (SCS) Regional Team, a component of the CERP Restoration Coordination and Verification (RECOVER) science program, is responsible for defining performance measures and setting restoration targets for these South Florida estuaries. Over the past 10 years, RECOVER's collaborative organization with Principal Investigators from government, non-profit, academia, and the private sector have developed several hydrologic and ecologic models to track CERP's achievements of its goals.

The Central Everglades Planning Project (CEPP) presented an opportunity for the SCS Team to practically apply salinity, seagrass, pink shrimp, juvenile seatrout, and juvenile crocodile models developed for CERP during the plan formulation phase of the project. Salinity models were initially applied to hydrologic sensitivity runs showing hydrologic effects from CEPP could be quantified in Florida Bay, resulting with the inclusion of Florida Bay in the alternative selection process. The salinity, seagrass, pink shrimp, juvenile seatrout, and juvenile crocodile models were then applied to CEPP alternative regional hydrologic model outputs. Results from these models helped guide the selection of and refinements to the CEPP Tentatively Selected Plan.

This presentation will introduce the hydrologic and ecologic models developed by RECOVER used to support CEPP Plan Formulation in the South Florida estuaries and the results generated by those models.

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UPSTREAM CONSTRAINTS AND THEIR EFFECTS ON QUANTITY, QUALITY, TIMING, & DISTRIBUTION OF EVERGLADES WATERS TO THE SOUTH FLORIDA ESTUARIES

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The Comprehensive Everglades Restoration Plan (CERP) is one of the largest ecosystem restoration projects in the world. It encompasses several distinct habitat types, from upland and wetland habitats to the estuaries of South Florida. One of the main challenges to the coastal ecosystem with regard to Everglades restoration is its physical location in reference to where the water starts in the system. The estuaries, by their very nature, are the final receiving bodies for a majority of water that flows south and east through the Everglades system. This means that upstream activities affect the quality, quantity, timing, and distribution (QQTD) of water to the coastal communities. The hydrologic and ecologic complexity of the ecosystem itself is even more complicated by the sheer number of stakeholder groups, each with their own vision of the final outcome of Everglades restoration. The Everglades landscape is a patchwork of Federal, Tribal, State, local government, and privately owned lands. CERP's main goal is to "Get the water right - QQTD" to support ecologic functions that represent a restored Everglades landscape. Water flows over the patchwork quilt of lands without regard to individual stakeholder or overarching constraints (e.g. water quality standards, threatened and endangered species regulations, cultural resources sensitivities).

This presentation will discuss several upstream constraints and their effect on the downstream coastal communities using model results from various ecosystem restoration and water control operational planning scenarios to illustrate the challenges in creating a unified vision of a restored Everglades ecosystem that is acceptable to all.

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UTILIZATION OF AN INTEGRATED RIVER BASIN MANAGEMENT (IRBM) APPROACH FOR THE MEKONG DELTA DEVELOPMENT PLAN

Dick Kevalam
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In its present state, the Mekong Delta is very vulnerable. Floods, droughts and salinity are dominant problems, hampering prosperous and sustained economic development. Socio-economic developments, climate change and upstream river basin management determine the future economic and environmental conditions of the delta. The Governments of Vietnam and the Netherlands have a strategic partnership related to climate change adaptation and water management. Ex-minister (Agriculture) and president of the Dutch Delta Commission (2008) Veerman has been appointed advisor to the Vietnamese Prime Minister. Within this framework a consortium led by Royal HaskoningDHV establishes a long-term vision and a strategic advisory plan for a safe, prosperous and sustainable Mekong Delta.

The Mekong Delta has outstanding natural resources and a comparative advantage for agriculture over other regions in Vietnam and even worldwide. At the same time the delta is one of the most vulnerable areas regarding its economic development, its low elevation results in flooding floods and salinity intrusion and its downstream position results in desired and undesired upstream river developments. Climate change and sea level rise will increase risk and overall vulnerability.

The main and most immediate driver behind the Mekong Delta Plan (MDP) is socio-economic development. The capacity to control floods, fresh water supply, salinity, and water quality depends heavily on the economic power of the delta and vice versa. Smart use of the natural land and water resources, either fresh or salt, contributes to the attractiveness of the delta for investors and to an overall reduction of required investments to cope with the typical land and water related problems of the delta. The MDP supports the government's intention to increase economic development, especially agro-business industrialisation. The delta suffers from outward migration of people seeking economic advantages offered in more industrialised regions. Managing the Delta in a way that promotes economic development is viewed as one way to halt this outward migration and increase economic stability. The MDP recommends better organization of farmers and government policies geared towards linking the partners in the agricultural value chain.

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GULF REGIONAL SEDIMENT MANAGEMENT MASTER PLAN (GRSMMP) - AN OVERVIEW OF THE SEDIMENT RESOURCES OF NORTHERN GULF OF MEXICO

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In order to enhance regional collaboration for ecological and economic health of the Gulf of Mexico (GOM), the Gulf of Mexico Alliance (GOMA) was established as a partnership of five northern Gulf of Mexico states viz. Florida, Alabama, Mississippi, Louisiana, and Texas. It was recognized that to advance conservation and restoration of coastal habitats and ecosystems throughout the GOM, sediment resources are integral to and a critical resource necessary in planning and implementing conservation and restoration activities. As a result, the Gulf Regional Sediment Management Master Plan (GRSMMP) was initiated to provide guidance for managing this valuable resource and substantiates the need for a comprehensive understanding of regional sediment systems and processes. The Plan is supposed to include strategies for the management of all sediment resources and to provide guidelines to the Gulf States for more effective management of sediment, recognizing that sediment are a part of a regional system involving natural processes and could not be partitioned along geographical boundaries.

The initial effort in the preparation of the GRSMMP was to establish and present a technical framework that uses the understanding of sediment dynamics to manage this essential resource. This framework provides an inventory of potential sediment sources, along with sediment needs; assesses competing needs for sediment; develops regional strategies that facilitate cooperation among stakeholders; and enhances abilities to make informed, cooperative management decisions. A key step in this process is the recognition that the technical framework provides a foundation associated with regional sediment management (RSM) processes that are essential for establishing management guidelines balancing sediment dynamics and available sediment resources. Issues surrounding sediment management, both natural and dredged sediments, have a considerable impact on the ability to sustain coastal habitats. Sediment management must occur on a regional scale unencumbered by agency, state, or political boundaries. Guidelines and recommendations from this effort will aid the Gulf States for more effective management of sediment resources, recognizing they are a part of a regional system involving natural and anthropogenic processes.

The main intent is for the GOMA partners to use the information concerning the regional sediment processes consisting of sediment inventories, sediment budgets and transport processes, navigation activities, ecological processes, and policy considerations as well as other regional priorities, and evaluate what this means in relation to current management practices around the Gulf. Outcomes from these evaluations will be the beginning of a process of formulating guidelines and recommendations on how management and planning practices can be improved to make better decisions on a regional scale. This approach will be critical towards improving the design, maintenance, and overall regional management throughout the Gulf.

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NORTHEAST FLORIDA BAY MINIMUM FLOWS AND LEVELS UPDATE, 2013 USING THE REGIONAL SIMULATION MODEL

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Florida Bay is an internationally recognized ecosystem that is adjacent to the Everglades, the largest subtropical wetland in the United States. Minimum Flows and Levels (MFLs) were established by rule in 2006 for northeast Florida Bay to prevent significant harm to the water resources, ecology, and ecosystem resulting from water withdrawals. MFL criteria focus on maintaining desired salinity conditions near the coastline, supporting freshwater-estuarine- marine ecosystems, providing natural-biological filtering and nutrient cycling, providing dry season refugia for aquatic wildlife, and preventing undesirable changes in seagrass vegetation and periodic algal blooms. Water deliveries to Florida Bay depend directly on the flow of water through Everglades National Park from upstream areas, especially the Water Conservation Areas and the South Dade Conveyance System.

One objective of the Florida Bay MFL update 2013 is to evaluate the effects of three distinct infrastructure and operational changes upstream of northeast Florida Bay that have been implemented or are imminent and were not in place in 2006 when the MFL rule was initially adopted. The Regional Simulation Model, a finite volume and object-oriented hydrologic model, implemented for the Everglades and the Lower East Coast Service Areas, was used for this evaluation. The model is capable of simulating the hydrologic conditions upstream of Florida Bay at a resolution that is adequate to assess the potential effects of implementation of projects that could affect hydrology in the area of interest. Two scenarios were simulated. A baseline simulation represents the 2006 condition when the MFL was adopted. A simulation with projects is identical to the baseline simulation with the addition of three projects: Everglades Restoration Transition Plan, C-111 Spreader Canal Western Project, and Tamiami Trail One-Mile Bridge. The primary area of interest is the drainage basin of northeast Florida Bay. Urban and agricultural water use demands represented in both simulations reflect 2010 permitted demands. The climatic period for both simulations is 1965-2005 that reflect a wide range of climatic conditions.

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REVEGETATION EXPERIMENT REVEALS NATIVE PLANT THRESHOLDS REQUIRED FOR ARTHROPOD ASSEMBLAGE RESTORATION

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Eosystem restoration must go beyond the revegetation of native plant assemblages to reconstruct the higher trophic levels that utilize those habitats. Arthropods are major pollinators, decomposers, herbivores, predators, and prey and are excellent early indicators of restoration success. Their assemblages are altered in coastal dunes invaded by highway iceplant (*Carpobrotus edulis*), which suppresses the growth of native plant species by forming dense, mat-like monocultures, stabilizing these naturally mobile dunes and increasing dead organic matter. In this study, I assessed how removing varying amounts of *Carpobrotus* and revegetating with native plant species affected the abundance, species richness, functional groups, and composition of terrestrial arthropods. If a critical threshold of native habitat exists, this information will aid land managers in planning and prioritizing restoration activities.

At Coal Oil Point Reserve in Santa Barbara, California, six 7x7 meter plots were established for each of five treatments: intact native dunes, *Carpobrotus* invaded dunes, 33% restored, 66% restored, and 100% restored. *Carpobrotus* was controlled in 2010 and the dead biomass removed, six native dune species were planted. Arthropods were sampled in 2013 using both pan traps and sand sifting, identified to family, and sorted by morphology to "morphospecies." Plant cover and Shannon diversity were characterized using point-intercept transects.

Intact and 100% restored plots had generally greater arthropod abundance and richness than unrestored and 33% restored plots, while 66% restored plots were more variable. These arthropod responses were strongly associated with plant diversity, which increased significantly with decreasing *Carpobrotus* cover. Functional groups varied in the proportion of native habitat required to approach the richness of intact plots. Omnivores reached their greatest species richness in intact, 100% restored, and 66% restored plots. Detritivores and predators were most species rich in intact and 100% restored plots, while herbivores and parasitoids were most species rich in intact plots only. Morisita-Horn species similarity for Hymenoptera, Coleoptera, and higher Diptera was very high between all restored and intact plots in soil samples, which were dissimilar to unrestored plots. In pan traps, intact, 100% restored, and 66% restored plots were very dissimilar to 33% restored and unrestored plots.

These results suggest that invasive plants should be removed on over 66% of a site and replaced with native plants for arthropod assemblages to approach the richness and abundance of intact native habitat. Species composition can approach that of intact habitat within three years of revegetation, but herbivore and parasitoid species, which are typically more specialized, may be particularly slow to recover.

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A NOVEL APPROACH TO WETLAND HABITAT RESTORATION: MAXIMIZING COLLECTIVE IMPACT THROUGH THE *PHRAGMITES* SYMBIOSIS COLLABORATIVE

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All plants contain microbes (e.g., fungi, bacteria) that live symbiotically with the host plants. These symbiotic relationships often confer competitive benefits to the host plants, including rapid growth and drought tolerance. Many believe that a thorough understanding of these symbiotic relationships may lead to innovative control methods for *Phragmites australis* (common reed) and other invasive plants by shifting the competitive balance away from the invasive. Similarly, these relationships may be integral to the growth of desirable species in restoration projects. However, we have many questions about these complex relationships, and isolated efforts to solve the puzzle will not provide the timely support that managers want. The collective impact of these efforts is only maximized through a coordinated approach applied to specific objectives. Therefore, the USGS – Great Lakes Science Center and the Great Lakes Commission are leading an international collaborative of scientists focused on developing microbe-based management approaches for invasive *Phragmites*. Specifically, this collaborative is focused on understanding the composition of the microbial assemblages and elucidating the roles that microbes play in competitive interactions between *Phragmites* and native plant species. Supported research efforts will focus on new tools to 1) disrupt symbiotic relationships between *Phragmites* and beneficial microbes to decrease competitive fitness and 2) promote beneficial microbial relationships in native plants to increase their competitive abilities. This collaborative is using the core components of a collective impact approach including a shared vision for the project through a common agenda, mutually reinforcing activities, consistent communication between stakeholders, and a backbone organization to coordinate the activities. Our application of this strategy to microbial symbiosis and the invasive *Phragmites* has produced promising results and could serve as a guide for similar efforts with other research topics. Moreover, this approach is working toward a series of symbiosis-based restoration strategies easily adaptable to other invasive species.

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PUBLIC ENGAGEMENT AND THE GULF COAST ECOSYSTEM RESTORATION COUNCIL

Bethany Kraft
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Passed in July 2012, the RESTORE Act dedicates 80 percent of all administrative and civil penalties related to the Deepwater Horizon spill to a Gulf Coast Restoration Trust Fund and outlines a structure by which the funds can be utilized to restore and protect the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, coastal wetlands, and economy of the Gulf Coast region. The Act also established the Gulf Coast Ecosystem Restoration Council (Council), which is responsible for restoring and protecting the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, coastal wetlands and economy of the Gulf Coast. The Council is committed to science-based decision making and to engaging the public throughout the process.

The Council approved an Initial Comprehensive Plan (Plan) in August of 2013 which will guide decision-making related to approving and funding projects for ecosystem restoration.

As the Council moves from planning to eventual implementation of restoration projects, engagement and communications strategies will be based on the concept of reaching out to the public early and often, which we describe as “upstream engagement”. Upstream engagement involves the public throughout the Council’s efforts to both maximize the unprecedented opportunities for large-scale restoration presented by the RESTORE Act as well as make good on commitments made in the Comprehensive Plan to engage the public throughout the process.

Given the Council’s limited resources and the large areal extent of the service area (Texas to Florida), one of the key challenges for the Council is how to engage a broader and more diverse community of individuals to engage in conversations about restoration who do not have specific technical or project expertise.

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THE PTERIDOPHYTE FIGHTS BACK!

Brooklyn Krings
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Coastal floodplain forests in the Louisiana Deltaic Plain are undergoing rapid relative sea level rise, resulting in extended hydroperiods and retreat of coastal forests. These floodplains support abundant floating macrophytes well suited to longer hydroperiods. Our study site is located in a backswamp at Jean Lafitte National Historical Park and Preserve in Jefferson Parish, Louisiana. The site is highly invaded by *Eichhornia crassipes* and this invasion has been detrimental to the natives. In 2011, the state-endangered floating macrophyte *Ceratopteris pteridoides* was observed co-occurring with *E. crassipes*. Since then, *C. pteridoides* has spread quickly and is present in high densities. Based on these field observations, we hypothesized that this native species can compete with *E. crassipes*. To test this we established field enclosures across the backswamp. The experimental design was a partial additive design using percent cover of *C. pteridoides* and *E. crassipes*. Species cover was assessed over the 2012 growing season. Overall, *C. pteridoides* increased in cover at the expense of *E. crassipes*. These results are compelling because they show a reintroduced native species exhibiting traits typically associated with invasions.

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UPDATE ON GULF COAST ECOSYSTEM RESTORATION COUNCIL ACTIVITIES

Robert Kröger
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The Gulf Coast Ecosystem Restoration Council (Council) is responsible for restoring and protecting the natural resources, ecosystems, fisheries, marine and wildlife habitats, beaches, coastal wetlands and economy of the Gulf Coast. The Council is committed to science-based decision making. Accordingly, decisions made by the Council will be made pursuant to the Initial Comprehensive Plan and will be based on the best available science which the RESTORE Act defines as science that "(A) maximizes the quality, objectivity, and integrity of information, including statistical information; (B) uses peer-reviewed and publicly available data; and (C) clearly documents and communicates risks and uncertainties in the scientific basis for such projects." The Council is also committed measuring outcomes and impacts in order to achieve tangible results and ensure that funds are invested in meaningful way. The Council will consider a variety of methods to measure and report on the results and impacts of Council-Selected Restoration Component activities and will include project- or program-specific measurement and reporting requirements in funding agreements with Council Members.

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RESTORATION OF OUR URBAN ECOLOGY TO IMPROVE WATER QUALITY

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The hydrology of East Baton Rouge Parish EBRP naturally divides into three main watersheds. Urban sprawl and flood protection channelization of this watershed has reduced, segmented, or eliminated natural ecological and beneficial functions of the watershed. Most of the rivers, streams, and bayous in the parish are listed as impaired and found to be "not supporting" for any of its designated recreational uses or fish and wildlife propagation. The Amite River, Comite River, and Bayou Manchac and its tributaries are severely impaired, at levels that require substantial intervention to remediate to fishable and swimmable conditions.

The continued loss of these wetlands coupled with the increase of channeled canals and concreted bayous have not only created additional pollution problems for the surrounding areas, but have significantly contributed to the flooding of the city along these canals and tributaries. The water quality and flow data collected in watersheds of EBRP suggest that most are impaired by nonpoint source pollution and that water flow has increased. However, the data collected has been at only a few sites and does not provide the necessary background information for determining which practices are critical to improving the health of the watershed. Without consistent quantitative data there is little justification for the city, parish and neighboring parishes and their stakeholders to implement Best Management Practices (BMPs). This is contributing to the continued degradation of the watershed.

As part of a solution to address the issues of the watersheds of EBRP, a Best Management Practices (BMP) handbook, videos, information bulletins, and posters were developed. The result of that work allowed for ordinance amendments to existing regulations in EBRP to implement effective BMPs for nonpoint source pollution reduction. The City of Baton Rouge –EBRP has also recently adopted a new 20 year comprehensive land use plan. Part of this plan includes an Environment and Conservation Element, requiring the local government to "prepare and adopt an erosion control ordinance to reduce adverse impacts of urban development and redevelopment on surface water quality." Moreover, the plan states that, priority should be given to using drainage areas as public space for trails and wildlife corridors. Restoration of waterways should include naturalization of stream banks and lake edges, development of riparian buffers along stream corridors, and reestablishment of wetland systems for better storm water collection and treatment.

A stakeholder Water Quality Enhancement Committee (WQEC) was formed to develop strategies for the implementation this plan that relate to protecting and conserving our environmental assets, and to foster a green, active, ecologically diverse and economically sound community. The committee is working on a strategy to canvass historical and current watershed data and combine this data with ongoing dynamic data to develop a storm water flow and local water quality data portfolio. This portfolio will be used by the WQEC and other stakeholder groups to help develop a demonstration site for educational programing. This baseline data will also be used to help resolve and prevent future storm water issues leading to improved storm water quality and flood protection and implementation of targeted BMPs.

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FITNESS FOR PURPOSE: TREE SEEDLING QUALITY IN FOREST RESTORATION

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Mining and other resource extraction industries are affecting more and more areas in the forests of North America. A priority in the reclamation and certification of forest lands disturbed by industrial activity is their expeditious redevelopment to forests. To rehabilitate these heavily disturbed areas back to functioning forest ecosystems, the planting of trees remains one of the most effective strategies for the redevelopment of a continuous tree canopy on a site. After landscape re-contouring and reconstruction of the surficial soils, the selection and establishment of trees is a critical initial step in generating forest ecosystems that support functioning soils and their processes, understories, and the higher trophic levels.

It is well understood that access to good quality seedling stock is essential to achieve establishment success and early growth of trees. However, most reclamation areas have challenging initial site conditions. To meet these demands, new methods for the production and evaluation of seedling stock types are needed to ensure that that seedlings are fit to grow on a wide range of site conditions or are particularly designed to grow in very specific conditions.

Generally, defining seedling quality is difficult, as it is specific to species and site conditions. In comparison to the vast amount of information that is available for the quality assessment of seedling stock used for reforestation, relatively little knowledge exists on the characteristics of planting stock indicating their suitability for afforestation. Quality planting stock produced for reforestations purposes is also often used in afforestation projects; however, this has yielded mixed results. In addition, much seedling research has focused on the production of coniferous species while much less research has been dedicated to the study of deciduous trees species. In this presentation I will show results from a range of studies that explore the role of seedling characteristics (such as seedlings size, growth strategy, root to shoot ratio, and nutrient and carbohydrate reserve status) as an assessment tool for stock quality and discuss their manipulation with respect to specific needs in forest restoration.

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A TALE OF TWO RIVERS--EVALUATING RESTORATION METHODS WITH BAYESIAN NETWORKS IN THE SOUTH RIVER (VA) AND PUYALLUP RIVER (WA).

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A major issue in management and restoring contaminated watersheds is the evaluation of different management tools in reducing risks to the system. This presentation presents the use of Bayesian networks originally developed to estimate risks within a system to estimate the utility of a variety of management treatments to two watersheds. The first case is the Puyallup River watershed (PRW), located in the Puget Sound Basin, and that drains a watershed from Mt. Rainer to the City of Tacoma, WA. The second watershed is the South River watershed (SRW), VA, a tributary of the Shenandoah River that was contaminated with Hg from a legacy manufacturing site in Waynesboro VA. In both watersheds we used the Bayesian network relative risk model (BN-RRM) to first estimate risk and then the efficacy of restoration strategies.

In the PRW study we initially calculated the risk of prespawn mortality of coho salmon due to nonpoint source runoff and other factors. Second, we evaluated the effect of low impact development (LID) also known as green infrastructure as a means to reduce risk. Prespawner mortality in coho salmon within the Puyallup watershed was the endpoint selected for this study. A conceptual model showing causal pathways between stressors and endpoints was created to show where linkages exist. A relative risk gradient was found throughout the watershed. The lowest risk was found in risk regions with the least urban development and the greatest risk of prespawner mortality was found in the highly urbanized risk regions with largest amounts of impervious surface. LID did reduce risk but only when implemented at high intensities within the urban watersheds.

In the SRW case we estimated risk of Hg and other stressors to four biotic endpoints and four water quality endpoints and evaluated remedial options. Through communication with decision makers we identified two management options for the site: bank stabilization and agricultural best management practices (Ag-BMPs). The management goals for the South River include “no regrets.” The managers do not want to make the site worse in any way, such as reducing mercury levels at the detriment of other endpoints. We have integrated these remedial options into our Bayesian networks risk assessment separately, as well as combined, for the biotic and water quality endpoints.

In both examples the use of BN-RRM allowed the calculation of both risks and the efficacy of very different management options. Given the success of these studies and the demonstrated broad applicability of the BN-RRM the technique should be transferable to other restoration activities.

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ECOGIG* AND TELESCIENCE: RESEARCH CRUISES UTILIZE IMMERSIVE TECHNOLOGY FOR DWH STUDIES AND RECOVERY EDUCATION

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The capacity to support restoration in the Gulf is likely enhanced by increased ocean literacy. Most of the region's ecological recovery education efforts are focused on easily accessible coastal areas. By studying and effectively communicating the underlying recovery mechanisms in the Gulf's less visible, and less understood deepwater ecosystems that remain impacted by the Deepwater Horizon event, ECOGIG (Ecosystem Impacts of Oil & Gas Inputs into the Gulf - a consortium of scientists from 14 research institutions compares the impacts of natural releases of oil in deep water ecosystems with those from abrupt perturbations, such as the Macondo Blowout.) researchers contribute crucial Education and Public Outreach (EPO) assets to create a holistic "Gulf-system" framework. When citizens understand and appreciate the relevance between the recovery of the Gulf's deepwater system and the more familiar coastal systems, they are more likely to be supportive of broad ecosystem restoration efforts. During multiple annual cruises, ECOGIG researchers regularly employ high-tech immersive technologies to chart the long-term effects and recovery mechanisms of the Gulf's deepwater communities. These telescience systems also provide superb opportunities to conduct EPO programs that employ a holistic "Gulf-system" approach.

For example, Dr. Charles Fisher recently led a team of ECOGIG scientists on a research cruise aboard EV *Nautilus*, (22 June-4 July, 2014) using *Hercules* and *Argus*, remotely operated vehicles (ROVs) that explore the seafloor in tandem to depths up to 4,000 meters. Dr. Fisher and his team continued their time-series studies of deepwater coral communities using the ROVs to image and sample their sites. ECOGIG's partner on this cruise, the Ocean Exploration Trust (OET) owns and operates *Nautilus*, and supports live video and audio streaming through its website NautilusLive.org. Given today's global internet connectivity, these technologies quite literally open up new undersea vistas – the last frontiers on Earth – and deliver real-time experiences to land-based scientists, students, the public and outreach partners. Live coverage is accessible from the seafloor and ship, and viewers can pose questions to be answered by scientists, engineers, science educators and ROV pilots in real time. The live stream highlights the on-going activities: viewers can see high-definition video of schools of fish, multibeam sonar mapping as the ship travels, or watch the ROVs activities on the seafloor, including imaging of corals. ECOGIG leveraged this capacity by aligning EPO and social media efforts with those of OET. Additionally, OET provides immersive at-sea experiences for students and educators through a variety of fellowships and internships. During the ECOGIG cruise, 3 undergraduates from across the US and 3 educators from across the globe were integrated members of the science party working directly with the ECOGIG scientists onboard. Research using telescience technologies advances ocean literacy, inspires future ocean explorers, and gives the public a live view of restoration science in action.

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RESTORING URBAN WETLANDS FOR INCREASED COASTAL RESILIENCY: ASSESSING NEEDS AND PRIORITIES IN NYC

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The vulnerability of New York City to sea level rise, and the increasing flood risk it will bring, has received intense focus since Hurricane Sandy - - the storm has also brought an unprecedented level of attention to coastal wetlands and the potential protective role they can play in NYC. For natural resource managers in NYC, however, protection of the over 2000 acres of salt marsh in the city has always been a priority. Over the last ten years, there has been a growing number of salt marsh restorations to counteract the threats from substrate erosion, vegetation retreat, and inundation from sea-level rise, and in parallel with those restorations, new research has arisen to both understand and incorporate into ongoing and future projects. To date, the primary salt marsh restoration processes in New York City have been building out eroded salt marsh islands with clean sand, and excavating both historic and recent fill from salt marshes and open-water areas to restore hydrology, a process by which over 100 acres of salt marsh were restored in the last four years alone. To prevent the net loss of salt marsh in NYC, in the future additional measures will likely be needed, including: widening culverts and retrofitting flood-prone roads located in marshes, re-constructing the water-ward extent of salt marshes that have eroded, adding sand to fragmented, eroding or retreating marshes, setting back berms and levees to allow more salt marsh expansion, and incorporating salt marsh restoration and creation into integrated coastal protection systems that span from off-shore breakwaters and oyster reefs to coastal forests.

Coastal wetlands restoration in NYC is extremely costly, particularly where contaminated fill removal is needed, and challenging due to competition for space and regulatory constraints. To better identify where coastal restoration projects should be prioritized, particularly on NYC Parklands, we have developed a framework to assess tidal wetlands restoration needs and opportunities. This framework incorporates information from several sources. The first is field data on ecological conditions within salt marshes to characterize conditions (including accretion and subsidence rates) and threats, restoration opportunities and appropriate actions. The second is parcel, or site-level, information generated from aerial photos, maps or field reconnaissance that identifies fill, encroachment, or flooding conflicts with existing land uses. The third source of information is analysis of historic mapping or photography identifying sites of significant wetland loss, and the fourth is modeling output on likely wetland extent under future sea level rise scenarios over the next century from SLAMM (Sea Level Affecting Marshes Model). Identified restoration opportunities are catalogued and evaluated for prioritization according to various criteria including: ecological value; cost; community, property ownership, and regulatory support; sustainability; constructability; social and economic values, and other factors. Our framework offers an approach to long-term planning for tidal wetlands restoration that incorporates a range of approaches, and accommodates adaptive strategies and improved understanding of salt marsh systems in a changing environment.

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NOAA RESTORE ACT SCIENCE PROGRAM: ADVANCING A HOLISTIC UNDERSTANDING OF THE GULF OF MEXICO

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The RESTORE Act authorized the National Oceanic and Atmospheric Administration (NOAA) to establish the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring, and Technology Program, commonly known as the NOAA RESTORE Act Science Program. The mission of the program, as directed in the Act, is to initiate and sustain an integrative, holistic understanding of the Gulf of Mexico ecosystem and support, to the maximum extent practicable, restoration efforts and the long-term sustainability of the ecosystem, including its fish stocks, fishing industries, habitat, and wildlife through ecosystem research, observation, monitoring, and technology development. The goal of the program is to support the science necessary for better understanding and management of the Gulf of Mexico ecosystem, specifically, healthy, diverse, sustainable, and resilient estuarine, coastal, and marine habitats and marine resources, including fisheries, and resilient and adaptive coastal communities. The program's focus areas are ecosystem structure, functioning, and connectivity; holistic approaches to observing and monitoring with advanced and innovative technologies and data integration tools; integrated analysis and synthesis of existing and new data to advance the state of ecological knowledge through the search for patterns and principles; and periodic state of health assessments, incorporating environmental, socio-economic, and human well-being benefits and elements.

In developing the program, NOAA has engaged stakeholders to identify and prioritize research and observing needs in the region. The program has released a science plan framework which incorporates stakeholder input and outlines NOAA's intent, purpose, and rationale for how it will execute the program. This framework informs the program's short-term priorities and is providing the foundation for the development of a more robust science plan for the program. The framework has also served as the basis for continued engagement with partners whose science needs will continue to be the driving force in the development and execution of the program.

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ITERATIVE PLANNING OF ECOLOGICAL RESTORATION AND ITS INCORPORATION INTO SOIL AND GROUNDWATER REMEDIATION

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The Former Nuodex Corporation site is a 185 acre parcel located in Woodbridge NJ. The site has been in industrial use for over one hundred years and is located in an industrialized area on the Raritan River. As a result of intense historical anthropogenic activity in the region and at the site, the natural hydrology and ecological habitats at the site have been substantially degraded. Historical disturbance activities at the site include the placement of fill and dredge spoils, construction of ditches and berms, creation of artificial ponds, filling of streams, clay mining activities, construction and operation of rail lines and development. These actions resulted in the alteration of tidal flow on the property and adjacent sites bordering the river and alterations to freshwater inflows due to infrastructure and development projects.

The site requires remediation to address contamination left from historic site operations, which offers an opportunity to restore open water habitats, freshwater tidal wetlands and riparian lands. A comprehensive remedial strategy was developed for the site based on participation by a diverse team of stakeholders including the current property owner, local, state, and federal officials, local environmental advocates, and a technical team of ecologists, engineers, geologists, and scientists. The remediation approach for the site includes a subsurface barrier wall, surface cover, and groundwater extraction and treatment system to physically and hydraulically contain impacted soil and groundwater within a 69-acre area at the site. The remediation and stormwater management systems were designed to deliver freshwater to the wetland systems while controlling the potential for contact with and transport of contaminants; not only protecting human health and the environment, but providing the opportunity to restore a habitat and enhance the local ecosystem. To manage the requirements of the remediation program while developing an ecologically functional and storm-resilient ecosystem, hydraulic modeling and water balance calculations were used to guide the wetlands design process, which created an interconnected series of wetlands and ponds relying on on-site surface and storm water flows and groundwater from outside the containment system.

The approved plans call for 40-acres of reconstructed/enhanced wetlands and ponds and 55-acres of enhanced riparian uplands with a network of trails and bridges to afford public access. Remedial construction at the site began in 2010 and is ongoing. The project team utilizes a collaborative and iterative design strategy to ensure that restoration and remediation goals can be met simultaneously during a fast-track construction project. The collaborative efforts resulted in development of a strategy to remediate the site while restoring degraded waters, wetlands, and riparian habitats, and providing access to the Raritan River for the first time in decades.

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CUTTING-EDGE TOOLS FOR ASSESSING ECOSYSTEM SERVICES AND MANAGING RESTORATION PROJECTS

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Among practitioners and supporters of ecological restoration, the intrinsic value of restored ecosystems is well understood and appreciated. However, the costs and impacts of restoration work often extend beyond the "restoration world." When trying to raise awareness of the value of ecological restoration and build support for specific projects, it can help to be able to directly assess and forecast the environmental and economic benefits of a restored ecosystem.

The i-Tree Suite of software tools, publically available from the USDA Forest Service, was designed to quantify the benefits, ecosystem services, and value of trees. The i-Tree tools have been used to great effect to increase funding and support for urban forestry, as well as for planning purposes. This software also has the potential to be applied to restoration projects where it can be used to quantify benefits such as stormwater runoff reduction, air pollution mitigation, carbon sequestration, public health benefits, and the economic value provided by woody vegetation. The i-Tree tools can be used to predict the outcomes of various restoration scenarios and to create measures of how well ecological restoration projects are functioning.

This talk will focus on specific examples of applications of the i-Tree software in quantifying some of the benefits of restoration projects. Adaptations specific to restoration work as well as the limitations of the software will also be discussed. The talk will follow-up on popular presentations delivered at recent SER conferences, with guidance crafted in response to feedback from ecological restoration practitioners as well as an overview of new 2014 i-Tree tools and features.

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HYDROLOGIC RESTORATION IS CRITICAL, PLANTING MANGROVE SEEDLINGS IS NOT

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Given the historical losses of mangrove forests around the Gulf of Mexico, attempts to restore lost mangroves have accelerated over the last three decades. Unfortunately, many of these well intentioned efforts have failed to establish persistent mangrove cover over time. Similar failed efforts have occurred around the world. Attempts to determine the reasons for these failures are hampered by typical funding restrictions for restoration attempts which support community based nurseries, and physical plantings of seeds or seedlings, but do not support pre-restoration investigations, nor post-restoration monitoring and reporting for meaningful periods, typically at least five years. Thus investigations of the causes of failures are largely limited to anecdotal observations and post-restoration site visits.

After 40 years of attempts to successfully restore mangroves, mostly in Florida, but including similar efforts in 22 foreign countries, I have developed and taught a method called Ecological Mangrove Restoration (EMR). It basically emphasizes careful characterization of the ecohydrology of whatever mangrove species is the target of the restoration effort, and topographic and hydrologic examination of control mangrove sites with comparisons to proposed restoration sites. A through understanding of both primary and secondary succession in mangroves of a particular locality are also important. Planting of mangroves is rarely needed as mangroves seasonally produce large quantities of floating propagules that quickly colonize appropriately prepared sites. Planting of appropriate nurse plant species such as smooth cordgrass may be essential in higher wave energy or erosion prone sites.

Case studies of several successful mangrove restoration sites as large as 500 ha will be shown to emphasize these points. The emphasis for successful restoration is pre-restoration investigations of conditions that prevent natural recovery of a given site. Hydrologic restoration is the preferred method of restoration for routine success and ecosystem restoration at minimum cost.

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AMAZON BIOMASS IN THE CARBON CYCLE-

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The variability of the physical-biological and climatic conditions of the Brazilian territorial space gave conditions to occupy this area with different types of applications, which combined to socio-economical nature factors as well as public and private sector investments, caused conspicuous environmental alterations.

These alterations might be observed in all Brazilian geographical areas, however conserving each one of them its specificity with regard to its intensity, environmental reflexes and those concerning life conditions and well-being of the population.

Presently, having a wide knowledge of the problems involved, these alterations allied to the technological development, might be detected quick and precisely through monitoring techniques, allowing the government and private enterprise to take immediate preventive and corrective measures. However, these measures are only possible due to the fact that the country possesses, at regional scale, the mapping and description of its natural resources, which has been provided for by RADAM-BRASIL Project and INPE(Spatial Research Institute). They studied all natural resources with four indicatives: localization, extension, qualification and quantification, and thus creating the basis to establish policies, which allowed the effective environmental managing. This managing has been very important in studies on speculations concerning the reduction of the tropical forest extension and its implications in the global carbon cycle. According to recent studies, the restructuring of these forests into areas destined for agriculture and pasture, results in a continuous carbon flow into atmosphere. The conference of nations that ratified the International Climate Convention that was realized in Kyoto, Japan, looked after mechanisms which might restore sustainability, under consideration of the different developing levels experimented by several countries of the world. There have been considered two guiding principles: the first guided by the reduction of the greenhouse effect gases and the second one concerning the reinforcement of the nature performance by means of natural neutralization of these emissions through natural sinks such as forests. In Kyoto has been created the Liquid Development Mechanism – LDM, through which the countries considered to be rich might account credits, in case their emissions exceed their pre-established quota, through financial compensations to development countries.

Studies are demonstrating the great importance of the Amazon Biome in the carbon cycle. This way, the biomass above the ground estimate is necessary to understand this productivity, nutrient allocation and carbon cycles. With the increasing interest for the CO_2 quota funding, these studies perform a primordial role in the area quantification and indirect estimate by means of equation models developed for each biome.

This study has the objective of presenting the 2013/2014 Brazilian Amazon Biomass estimates in the Carbon Cycle. There are presented a revision on Biomass and estimates indexed by latitude and longitude regarding the Amazon Forest, as well as an analysis on the Atlantic Forest using available technological instruments, and thus aiming to contribute to the Brazilian environment managing.

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SALINITY AND NUTRIENT IMPACTS ON SAV ABUNDANCE AND DISTRIBUTION IN BISCAYNE BAY

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Nearshore benthic habitats of Biscayne Bay fit the prediction of communities at risk due to their location adjacent to a large metropolitan center (Miami) and being influenced by changes in hydrology through the activities of the Comprehensive Everglades Restoration Plan (CERP). We examine whether the proposed programmatic expansion of mesohaline salinities through the introduction of additional fresh water would result in: 1) increases in seagrass cover; 2) expansion in the cover of *Halodule*; and 3) a reduction in the dominance of *Thalassia,* as hypothesized by CERP. Salinity was the only physical variable with a significant relationship to the occurrence of all SAV taxa. Occurrence of *Thalassia*, *Halimeda*, and *Penicillus* increased significantly with increasing salinity, but *Halodule, Syringodium*, *Laurencia, Udotea, Batophora, Caulerpa,* and *Acetabularia* showed a significant negative relationship with salinity. The salinity range in which both *Thalassia* and *Halodule* had similar frequency of occurrence was 15-25 psu. The combined cover of *Thalassia* and *Halodule* when both species are present (23%) is higher than the cover when only one of the species is present (17.4 % for *Thalassia* and 19.7 % for *Halodule*). The low abundance of *Thalassia* along the shoreline is not only due to its exclusion from low-salinity environments but also by higher nutrient availability that favors *Halodule*. Percent N, P, and N:P ratios in seagrass tissue suggest that Biscayne Bay receives high N inputs and is P limited. Thus, increased P availability may facilitate an expansion of *Halodule*. The data collected suggest that increased mesohaline salinities will increase seagrass abundance and support co-dominance by *Halodule* and *Thalassia* as hypothesized, but raise concerns that current high N availability and the potential for increases in P may prompt a shift away from seagrass-dominated to algal-dominated communities under scenarios of enhanced fresh water inputs.

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INTEGRATING ADAPTIVE MANAGEMENT INTO PROJECT LIFECYCLE PROCESSES

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Adaptive Management (AM) provides a means for reducing uncertainty and thereby allowing decisions to be made and progress to be gained. AM has been well integrated into many science programs to help reduce scientific uncertainty with varying degrees of success. These science programs are often part of a larger project or program. Like the science programs embedded within them, these larger projects and programs have their uncertainties that must be resolved if the project or program is to be implemented and achieve success.

The lifecycle of a project or program typically includes phases of studying, planning, designing, constructing, operating, monitoring, etc. Each phase may contain its own uncertainties. These may be scientific, engineering, legal, policy, or other uncertainties. AM provides a means for solving problems through answering unanswered questions and reducing uncertainty such that each of these phases can proceed in an orderly fashion.

Applying AM throughout the lifecycle of a project or program requires integrating it ineach phase. This will keep AM from being misunderstood and viewed as something that only the scientist are concerned with and will help develop a mindset that embraces AM as the problem solving method of choice within a project team or implementing organization. For this to be successful, AM must be applied under and supported by a governance structure that understands AM, values it, and is willing to commit the necessary resources to allow its processes to work.

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ANALYSIS AND LESSONS LEARNED FROM MARDI GRAS PASS (MGP) WITHIN THE BOHEMIA SPILLWAY, SE LOUISIANA

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Mardi Gras Pass (MGP) is a new river outlet that LPBF has monitored since the 2011 flood of the Mississippi River. At river mile 43.4, MGP is 47 miles below New Orleans on the east bank. It is within the Bohemia flood spillway created in 1926 by removal of artificial river levees, and thus allowing overbank flow from the river toward the adjacent marsh and nearby Breton Sound.
The development of MGP is a rare opportunity to document riverine and deltaic processes related to crevassing, avulsion, and distributary development, which is generally precluded on the lower Mississippi River due to flood and navigation engineering, such as river levees, which generally constrain flow to the main stem of the Mississippi River. Initially, headward erosion in MGP occurred during high water of 2011 and 2012, which allowed the head of the MGP channel to migrate up-current and breach the Mississippi River by February 2012 (during Mardi Gras). After breaching, the thalweg of the entire channel had negative elevation, meaning that the channel was hydrolgically connected to the river at any river stage, i.e., continuously.

Due to the establishment of this connection to elevated river stages of the Mississippi River and with near mean sea level of the adjacent marsh, the discharge in MGP has been free-flowing, and driven daily by the head differential. During low river stage, the head is less than 2 feet and the flow can occasionally reverse, allowing minor flow from the marsh into the river. During high water river stage, head may be as great as 8.5 feet with a maximum expected river stage of 7.6 feet and low astronomical tide in the marsh. This is a very large head differential for the very low landscape elevation of the Louisiana delta plain. With the large head and consequently high velocity flow, the evolution of MGP channel has been dominantly degradational (erosional); whereas, downstream of MGP processes are dominantly aggradational (depositional) within canals or natural waterways which capture flow from MGP.

MGP is a classified as G6 in the Rosgen stream classification, and had average dimensions of 95.8 feet width and 13.4 feet depth in August 2012, but has enlarged since that time. The measured discharge has increased since the initial breach in February 2012 from 200 cfs to 3,840 cfs in May 2013. As of December 2013, LPBF estimates that MGP could have theoretically flowed as much as 5,200 cfs with maximum head conditions. By the end of the 2014 flood, we estimate the maximum potential discharge may be between 6,000 and 12,000 cfs. Observed geomorphic/stream processes in MGP include: headward erosion, bank erosion/slumping, base channel erosion, scour holes, logjams, sinuosity, eddies, waterfalls, and standing waves.

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DEVELOPMENT OF ADAPTIVE MANAGEMENT STRATEGIES TO IMPROVE CENTRAL EVERGLADES PLANNING PROJECT IMPLEMENTATION

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Adaptive management is an applied science approach to addressing uncertainty associated with the risk of achieving natural resource management and/or restoration goals. USACE implementation guidance for WRDA 2007 Section 2039, the 2003 Programmatic Regulations for the Comprehensive Everglades Restoration Plan (CERP), and CERP Guidance Memorandum 56 require development of adaptive management plans to help guide restoration implementation. The Central Everglades Planning Project (CEPP) is one grouping of CERP project components formulated to address restoration goals and objectives in the central section of the Everglades. This paper discusses how science was applied to develop the CEPP adaptive management to inform implementation of the CEPP project and improve restoration performance.

The CEPP adaptive management plan provides strategies to address prioritized project uncertainties that will be faced as CEPP progresses toward achieving restoration goals and objectives while remaining within constraints. Each strategy follows a scientific approach that identifies hypotheses about how the ecosystem will respond to CEPP project components when implemented. Strategies include performance measures that identify expected performance, monitoring to assess actual performance, and triggers and/or thresholds to inform restoration progress and support decisions regarding the need to adjust CEPP to improve restoration performance. Strategies also list management options matrices that link the science to potential management options intended to inform decision-makers, CEPP partner agencies, and the public on potential actions to improve restoration performance based in part on feedback from the monitoring. Management options can be categorized as the following: 1) design updates of subsequent project components, 2) changes in project operations as part of a system of water management structures, and 3) implementation of contingency options that may require additional restoration actions, such as, vegetation management or tree island planting, to improve overall restoration success. Implementation of adaptive management options is not automatic. The options are suggestions that capture current understanding of potential future issues and solutions and still require consideration of applicable policies and laws before they would be implemented. In summary, the CEPP adaptive management plan identifies how the science developed by RECOVER will be applied to inform CEPP implementation and improve achievement of restoration success.

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EVERGLADES ECOSYSTEM RESTORATION STATUS: SCIENCE BASED ASSESSMENT OF RESTORATION PROGRESS

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The 2014 System Status Report (SSR) evaluates current monitoring data to determine if the goals and objectives of the Comprehensive Everglades Restoration Plan (CERP) are being met. The report incorporates data collected by the Restoration Coordination and Verification (RECOVER) Monitoring and Assessment Plan (MAP) program for CERP, data from CERP projects and data provided by RECOVER partners. The goal of the MAP program is to document status and trends of the essential and defining attributes of the south Florida ecosystem. These RECOVER monitoring data are used to assess the status and trends in hydrology affected by restoration project implementation and system water management operations, as well as in ecological parameters (e.g., wading birds) that respond to changes in the quantity, quality, timing and distribution of water. This information is measured against pre-CERP reference conditions and is used to help determine if the goals and objectives of CERP are being met.

This comprehensive understanding of the system enables the successful use of adaptive management principles to track and guide restoration activities. Although CERP implementation has been slower than originally envisioned, progress in project construction and operation has begun in some areas, especially in the Southern Coastal Systems region of the Everglades. The Key Findings from 2014 System Status Report (SSR) will be used to assist decision-makers on the timing of planning and implementation of CERP features. These data also inform the scientific community in south Florida and provide a basis for such planning efforts as the Central Everglades Planning Project (CEPP). The 2014 SSR also provides input into the 2015 Report to Congress, required by the Water Resources Development Act of 2000. Produced every five years, the intent of the Report to Congress is to inform the highest levels of the United States government on the progress made toward the goals and objectives of the CERP.

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ROLE OF SYSTEM-WIDE ECOSYSTEM RESTORATION ASSESSMENTS IN THE EVERGLADES ADAPTIVE MANAGEMENT PROGRAM

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The Comprehensive Everglades Restoration Plan (CERP) was authorized by the United States Congress, as part of the 2000 Water Resources Development Act with its fundamental goal to capture most of the fresh water that currently flows unused to the ocean and gulf and deliver it when and where it is needed most throughout south Florida. The bold plan included 68 plus project components to improve the health of over 2.4 million acres of the south Florida ecosystem. Congress recognized that uncertainty existed in implementing CERP and achieving the plan's goals and objectives. CERP was authorized under the expectation that adaptive management principles would be applied to update its implementation based on knowledge gained throughout the process. A key element of the adaptive management program was the adaptive assessment and monitoring program also authorized to fund monitoring of ecosystem status and reporting of key results to inform managers on achievement of restoration progress or performance issues requiring adjustments.

The Restoration Coordination and Verification (RECOVER), a system-wide interdisciplinary science team made up of representatives from 12 agencies and tribes, developed the Monitoring and Assessment Plan (MAP) to provide the framework for what monitoring was needed and how it would be assessed and reported to support adaptive management implementation. These MAP monitoring data are used to assess the status and trends in hydrology affected by restoration project implementation and system water management operations, as well as in ecological parameters (e.g., wading birds) that respond to changes in the quantity, quality, timing, and distribution of water. The Everglades system status report is used to convey these monitoring results to a variety of audiences in a several formats. Monitoring information is measured against pre-CERP reference conditions and is used to help determine whether the goals and objectives of CERP are being met. Results are analyzed in a hypothesis based approach to determine not only what is happening in the system, but why. In addition, multiple lines of evidence are used to help increase confidence in the why. Ultimately, we have learned that managers prefer integrated synthesis reports that are short and to the point and linked to some potential next step that requires their input. Key findings have been developed along with a core storyline of what is happening to help meet this need.

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HYMENOXYS TEXANA – ENDANGERED PLANT MITIGATION FOR NEW ROAD

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The primary function of the Endangered Species Act (16 U.S.C. 1531 *et seq.*) is to ensure that any action that is federally authorized, funded, or carried out is not likely to jeopardize the continued existence of a listed threatened or endangered species or result in the destruction or adverse modification of designated critical habitat. *Hymenoxys texana*, Texas prairie dawn, is a listed endangered plant endemic to the Upper Texas Coast and is found primarily in Harris and Fort Bend Counties, Texas, USA.

Harris County is one of the most rapidly growing counties in the USA with a continuous need to update and expand its infrastructure. The Harris County Public Infrastructure Department proposed using federal funds and fill less than ½ acre of wetlands by extending an existing four-lane roadway over an existing railroad tracks and adjacent drainage ditch to improve east-west traffic flow and local traffic congestion in northwest Harris County, Texas. With the physical constraints of the existing road, other roadways and structures, and the required railroad/drainage ditch overpass, the right-of-way for the proposed roadway extension could not be designed to completely avoid a local population of Texas prairie dawn.

A biological assessment was prepared that reviewed the history, habitat type, and required hydrology of Texas prairie dawn to develop a mitigation and preservation plan. The required hydrology is associated with a local soil phenomenon (small pimple mounds) known as mima mounds. Mima mounds have specific soil profile that creates saline conditions along the sides and on top of the mounds. The mitigation and preservation plan incorporated specific conditions to protect the hydrology associated with a population of Texas prairie dawn that is adjacent to the proposed right-of-way. The mitigation area incorporated approximately 4.2 acres to protect the hydrology of the mima mound, and therefore the population of Texas prairie dawn. The mitigation area was fenced and a berm placed around the perimeter to ensure that runoff from the surrounding areas would not adversely affect the mitigation area. Harris County Precinct 4 Parks Department is the entity responsible for the long-term maintenance of the mitigation site with guidance from the Botanist at Mercer Arboretum and Botanic Gardens; one of the 38 leading botanical gardens and arboretums in the United States that maintains the National Collection of Endangered Plants for the Center of Plant Conservation.

With the proposed mitigation and preservation plan in place, the U.S. Fish and Wildlife Service biological opinion concluded that construction of the proposed roadway would not likely jeopardize the continued existence of *Hymenoxys texana*. Construction of the roadway and mitigation area was completed this year.

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OVERVIEW OF THE LULING, LOUISIANA WETLAND CARBON CREDIT PILOT PROJECT

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This presentation provides guidance on the first-of-its-kind American Carbon Registry (ACR) methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* which was developed by Tierra Resources to transact wetland carbon credits derived from wetland restoration. The ACR methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* provides a rigorous scientific framework for project development and aims to give offset credit for a wide range of restoration techniques including hydrologic management as well as reforestation with a variety of species. The methodology is also unique in that it utilizes a modular approach to streamline the methodology to meet a variety of local conditions and different restoration techniques. The modular methodology addresses each aspect of the project from establishing a baseline, monitoring of eligible carbon pools, and estimating project emission reductions, as a discrete and independent module. The presentation will provide a detailed description of carbon credit requirements and monitoring efforts as they apply towards carbon credits at the nation's first carbon credit pilot project.

The nation's first wetland carbon credit pilot project is located in St. Charles Parish approximately 19 miles from New Orleans. The objective of this pilot project is to deliver a proof-of-concept carbon offset project at the wetlands near Luling, Louisiana, to address science gaps, "road test" the developed methodology, determine costs, benefits, and barriers to implementation, identify cost-saving measures, and potentially produce commercially viable offsets. This is the first wetland offset pilot project in the nation that also demonstrates the ability to create public private partnerships that leverage carbon finance. The results will inform managers and developers on how to develop wetland carbon credits that are compliance eligible, economically competitive, and scientifically defensible.

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WETLAND CARBON OFFSETS OF THE MISSISSIPPI RIVER DELTA

Sarah K. Mack[1], *Robert R. Lane*[2], *John W. Day*[2], *Christine Yankel*[3], *Richard Kempka*[3]
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This presentation provides guidance on the first-of-its-kind American Carbon Registry (ACR) methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* which was developed by Tierra Resources to transact wetland carbon offsets derived from wetland restoration. This is the first wetland offset methodology in the world to be applicable at a large scale and broadly address wetland restoration.

The ACR methodology, *Restoration of Degraded Deltaic Wetlands of the Mississippi Delta,* provides a rigorous scientific framework for project development and aims to give offset credit for a wide range of restoration techniques including hydrologic management as well as reforestation with a variety of species. The methodology is also unique in that it utilizes a modular approach to streamline the methodology to meet a variety of local conditions and different restoration techniques. The modular methodology addresses each aspect of the project from establishing a baseline, monitoring of eligible carbon pools, and estimating project emission reductions, as a discrete and independent module. The individual modules that are applicable to a specific wetland restoration project can then be selected and applied under a framework module which results in a project-specific methodology. These modules, when used together will ensure the environmental integrity and robustness of ACR restoration projects, and will prevent certification of poorly designed wetland restoration activities.

This presentation will also discuss the results of a commercialization study focusing on the costs, benefits, and barriers to implementation, cost-saving measures, and the potentially to produce commercially viable offsets.

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RESTORATION OF FORB AND WOODY SPECIES IN THE TEXAS HILL COUNTRY

David Mahler
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During the last 180 years, much of the central Texas hill country has lost a significant percent of its plant species through the combined effects of fencing, and through heavy grazing and browsing by goats, sheep, cows and horses. Elimination of burns traditionally set by indigenous peoples, and suppression of natural fire has also contributed to plant species degradation. Furthermore, a large reduction or elimination, of key species crucial to habitat stability, such as buffalo, wolves, mountain lions and screw worms has been a factor. In addition to the degradation of the native grass species, much of the range land in the region now has a greatly reduced quantity and quality of browse species. While significant research has occurred in the reestablishment of the grass component of the Texas hill country region very little has been done on the much more difficult and slower process of the restoration of depleted browse species.

In our attempts over the last 25 years to restore the greatly reduced forb and woody species of the 1200 acre Spicewood Ranch in Spicewood, Texas, we developed a dual process of simultaneously reducing the white-tailed deer population in the main high fenced part of the ranch, while starting to reestablish the woody and forb browse species that are able to survive the current browse pressures. This required the development of a list (included in this report) of hill country native forb and woody species ranked for their edibility for white-tailed deer. We started the restoration process by first reestablishing populations of the barely edible species that were
Nonetheless missing from the ranch or were severely restricted in the presence of white tail deer. As these species have become established in greater numbers and provided more available browse, we have been able to successfully sequentially introduce additional browse species with progressively higher edibility and nutritional value. Our goal is to eventually get browse pressure lowered through this process so that all of the species likely to have previously existed in this habitat will be able survive, browsing by the native white-tailed deer on this site.

This process has involved: 1-experimenting with growing the missing woody and forb species from seed in exclosures to determine their propagation requirements; 2-locating remnant seed sources and increasing the seed of rare native species in the exclosures for eventual seeding on the main ranch; 3-frequent experimental testing of new species on the ranch outside of exclosures to determine if they are yet able to survive under the decreasing browse pressures of
the ranch; and 4-refinement of our ranking of the edibility of these species based on our experiments on the ranch and observations and plantings on numerous sites in nearby counties.

Example of the progress which has been made with restoration of the browse species on this ranch over the last 25 years are provided.

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INNOVATIVE APPROACH FOR USING BUILT WATER RESOURCES INFRASTRUCTURE FOR ECOSYSTEM RESTORATION

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The U.S. Army Corps of Engineers maintains an extensive national system of Locks and Dams across the nation's navigable rivers. These systems commonly force river flows through gates, valves, or lock chambers of considerably less cross-section area than the river immediately upstream or downstream of the dam. During such times, Lock and Dams offer the opportunity to partially control the movement of fishes, particularly in the upstream direction. It is well known that small changes in dam operation or specific design features of fishways may favor or impede different species of fishes, depending upon individual species behaviors or their swimming capabilities. For example, pool and weir fishways favor surface-oriented (jumping) fish species over benthic (non-jumping) fishes. Consequently, these systems have the potential to be designed or operated to selectively favor the passage of native fishes, while impeding the movement of invasive aquatic species, as part of a watershed fish conservation or ecosystem restoration plan.

The Army Corps of Engineers' Pittsburgh District recently evaluated fish passage project feasibility at the three Ohio River lock and dam navigation facilities within Pennsylvania. Traditional fish passage structures were determined infeasible for a variety of structural, hydrologic and economic issues; yet, the District is considering whether replacement lock chambers can be redesigned to increase the passage of native fish, while reducing the spread of nuisance species, such as Asian carp, to determine if a Lock and Dam system can selectively pass different species of fishes as part of a river management plan. Literature searches revealed little prior consideration of lock design modification to favor fish passage. Any lock modifications facilitating fish passage through normal lock operations would benefit longitudinal connectivity and aquatic restoration efforts. Application of any improvement in fish passage through navigational lock chambers could extend across the majority of the Corps' 238 locks at 192 lock and dam navigation facilities on over 12,000 miles of the nation's rivers.

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ENGAGING THE PUBLIC IN PLANNING AND IMPLEMENTATION

Camille Manning-Broome
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Historically, Louisiana's communities and leaders have not extensively planned around land use and community development. With the disasters of 2005 and 2008, planning in Louisiana has become one of the key activities to address recovery, coastal protection and restoration, and community development and redevelopment. However, residents are not accustomed to participating in planning processes to direct growth, development, and redevelopment, while those leading the planning process lack capacity to effectively engage the public. This results in low public participation, presentations that are too technical to reach the general public, and a feeling by citizens that their seat at the table is not desired. To address these issues, the Center for Planning Excellence (CPEX) has developed methods to get people excited about and engaged in planning. Our approach ranges from getting people to public meetings to bringing demonstration projects to them.

CPEX has assisted over 20 communities across Louisiana in their planning and implementation processes. Through this work, CPEX has learned the value of meeting people where they are to ensure the opportunity to participate is given; of concerns and ideas citizens bring to the table, even though not all can be accommodated; and of planning staff that understand how to effectively engage people at public meetings and provide them with the information that is easy to understand and empowers residents to participate in a meaningful way. Public involvement is a key ingredient to successful planning and implementation at all scale and citizens have to be involved in restoration planning efforts.

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WHAT IT REALLY TAKES TO TEST HYPOTHESES CONCERNING ECOSYSTEM RESTORATION AND SPECIES RECOVERY

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Adaptive Management (AM) is a rigorous approach to environmental management designed to explicitly address and reduce uncertainty regarding the most effective on-the-ground actions for achieving management goals and objectives, including ecosystem restoration and species recovery. But it isn't easy, particularly at larger scales, where replication is difficult, ecosystem / species response times may be long, and confounding factors abound. This presentation reflects some insights we've gained over the last 20 years of applying AM to several river basins, including the Trinity, Russian, Columbia, Okanagan, Platte and Rio Grande. We briefly describe 'ideal AM', and provide examples of rigorous adaptive management designs for ecosystem rehabilitation and species recovery in Western North America. We emphasize the need for strong contrasts in management actions, replication and randomization of actions at smaller scales, coupled with rigorous monitoring and evaluation (M&E) that provides clear signals for revising hypotheses and management actions. We then examine various spatial and time scales of AM in restoration / recovery programs using real world examples from the above 6 river basins, providing a candid assessment of where / when it is feasible to rigorously test hypotheses, and where / when it isn't. We highlight progress made over the last few years (e.g., improved sampling designs and monitoring protocols which permit the detection of smaller effect sizes) and summarize a hierarchy of 10 institutional and technical factors that can either enable or inhibit AM in programs for ecosystem restoration and species recovery (see Greig et al. 2013. Insight into Enabling Adaptive Management. Ecology and Society 18(3): 24).

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IMPROVEMENTS TO FATHOM, A SALINITY AND WATER QUALITY MODEL FOR FLORIDA BAY – LESSONS LEARNED FOR EVERGLADES RESTORATION

***F. Marshall*[1]*, B.J. Cosby*[2]*, W. Nuttle*[3]*, S. Kemp*[4]*, and E. Stabenau*[5]**

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FATHOM (Flux Accounting and Tidal Hydrology at the Ocean Margin) is a spatially explicit, dynamic model designed to simulate the movement of water and solutes in Florida Bay in response to runoff, climate, tides and the topography of the Bay. The model maintains a mass-balance of water, salt, nutrients (N and P), dissolved oxygen, and temperature in 54 basins. Exchanges between these basins are driven by differences in water levels, bank width between basins, depth of flow, and bank bottom roughness using Manning's equation. Solute exchanges are then calculated from exchange volumes and solute concentrations. Model inputs include monthly time series for rainfall, estimated average evaporation, freshwater (coastal creek) inflows, and hourly tide stages along Gulf of Mexico and Atlantic Ocean boundaries. Monthly changes in mean sea level at the boundaries and long-term trends in annual average sea-level are added to the tide data. Bathymetry data were derived from NOAA charts and USGS survey data collected in Florida Bay. FATHOM simulations of monthly Florida Bay salinity from observed inputs account for greater than 75% of the variation in the observed data for the period 1991-2002 at 20 sites within the Bay.

In addition to salinity, FATHOM produces monthly values of residence times, water depths, wetted surface areas, water volumes, exchange between basins and velocity profiles. FATHOM has been programmed to simulate nutrients, dissolved oxygen, and physical parameters such as temperature, though work is still needed to make this module fully operational.

This presentation will review the results of the recent calibration/verification exercise, which included optimization of the Manning's coefficient, freshwater inflows, and other input parameters. FATHOM can now be utilized to make predictive salinity simulations based on the Everglades hydrologic response to proposed and already-constructed Comprehensive Everglades Restoration Plan (CERP) projects or similar data from paleoecological studies. Results of the calibration/verification exercise indicate that circulation in the Bay is mostly compartmentalized within areas of the Bay that were previously identified as regions of similar water quality by Briceno and Boyer (2010). These results also show the relative importance of the physical and hydraulic characteristics that vary across the Bay in a manner consistent with published studies. FATHOM simulations of Florida Bay salinity for the period 1965-2000 in the absence of water management using paleo-based flows as input are similar to the paleo-based estimates made by Marshall and Wingard (2012). A study is currently underway to use FATHOM for simulating the effects of sea level rise and other climate change factors on salinity, water quality, and basin morphology.

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HOW MUCH IS THE CARBON SINK IN THE VEGETATION OF A TROPICAL PASTURE?

***Jose L. Martinez**, Ofelia Castillo and Luisa Camara*
Universidad Juarez Autonoma de Tabasco, Mexico

Each year the pasture ecosystems represent a greater extent worldwide because of its strong association with the production of food, mainly meat and milk. Besides, this ecosystem represents the extent of the original vegetation that has been lost and converted into transformed ecosystems which returns to its original or similar vegetation in a very small rate. Because of this, this ecosystem with a slow but steadily higher expanding rate, has greater environmental and ecological weight worldwide because of the carbon cycle. The aim of this study was to estimate the carbon stocks of a typical tropical pasture in Mexico, expecting that although the significant amount of carbon stored in the vegetation this figure would be lower than in the original wood ecosystems, then justifying the ecological restoration.

Two pastures of about 10 ha each, with the most common grass species in the area (*Brachiaria decumbens* and *Paspalum notatum*) for livestock (*Bos taurus*) were selected in the southern state of Tabasco, Mexico (17°45”- 18°00” North, 92°45”- 93°00” West). In each pasture three plots of 40 x 40 m were located, and within these ten boards of 2 x 2 m were randomly placed for biomass harvest and total organic carbon (TOC) estimation. For this, vegetation was allowed to grow up to the inflorescence stage excluding cattle with a fence. For roots sampling 1.50 X 0.50 X 1.0 m holes were dug and ten soil subsamples 0.15 X 0.15 X 0.10 m were collected downwards every 10 cm up to 1 m depth (Ahedo, 2001). All biomass was oven dried at 70 °C for three days. The TOC was estimated by the method of organic carbon on ignition using the formula %C.O. = %M.O. / 1.724. The values were extrapolated to one hectare (Schlönvoigt, 2000 cited in Hernán et. al. 2001).

A total of 39 species were found in the pasture of *B. decumbens* with two dominant families: Poaceae and Fabaceae. In the pasture of *P. notatum* 42 species were found being the dominant families Poaceae, Fabaceae, Euphorbiaceae and Rubiaceae. Stored C was slightly higher in the roots than at the aerial part or grass foliage, finding the largest stock in the first 40 cm depth. Pastures of *P. notatum* stored 5.2 t C / ha in the root part and 1.8 t C / ha aboveground, while *B. decumbens* stored 2.9 t C / ha in the root portion and 2.8 t C / ha in the aerial part. By contrast, aboveground wood vegetation in the area store around 70 t C / ha (Martinez-Sanchez and Camara 2012). Clearly, C stocks of tropical grassland, although significant, is much smaller than the original wo.od vegetation stocks, so from the point of view of carbon sequestration, grasslands should be restored at the possible extent to the original vegetation.

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AN INTERFACE OF COMMUNITY WELLBEING AND WATERSHED RESTORATION IN SOUTHERN BRUCE COUNTY

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Increasing the connectivity and water storage capability of functioning Riparian areas within watersheds, as a mechanism of increasing the resiliency, well-being and capacity of watershed communities has been the recent focus of the restoration work in Southern Bruce County. A qualitative investigation exploring the community uptake of restoration projects and their relationship to the goals of increasing ecosystem health and water quality, specifically in the Pine River Watershed, Little Sauble Watershed, Willow Creek Watershed, as well some examples taken from the Teeswater and the Saugeen River Watersheds, has been under taken.

The work done over the last 12 years by a grass roots watershed restoration group titled the Pine River Watershed Initiative Network in their efforts to restore "clean water and a healthy ecosystem in the Pine River Watershed has been considerable. The Pine River Watershed drains into Lake Huron just north of Point Clark, Ontario and has been identified as a priority watershed by the Healthy Lake Huron working group. The Healthy Lake Huron Working Group is co-chaired by Ministry of Environment and Environment Canada staff, as part of the work set out to meet the requirements of the Canada Ontario Agreement which pertains to commitments made under the Binational Treaty on Great Lakes Water Quality . The Pine River Watershed is highly agricultural and is home to several community champions who have furthered restoration efforts to include: over 200,000 seedlings planted; 3 wetland complexes constructed; an experiential environmental education centre created; 6 onfield berms constructed to slow down runnoff and filter out sediment loading; over 8 km of cattle exclusion fencing; 5 cattle crossings; 4 alternative water sources for cattle; 4 nitrate filters; and a series of trails for people to walk to enjoy the beauty of the watershed. These accomplishments will be highlighted with a focus on the strong community cohesion and relationship to the landscape that has driven this committed work.

Two barriers have been identified as limiting the scope of the restoration work in Southern Bruce County: Funding and Community uptake of the ideology surrounding restoration ecology.
Through surveys, focus group and interview work an examination of motivations to complete this restoration work has been investigated. With the results showing that personal connection to the landscape is one of the driving forces behind the volunteerism that has been so influential to the large amount of ecological restoration work completed in this region.

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ENHANCED MANAGEMENT OF AVIAN BREEDING HABITAT INJURED BY RESPONSE IN THE FLORIDA PANHANDLE, ALABAMA, AND MISSISSIPPI

Amy L. Mathis
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On April 20, 2010, approximately 50 miles off the Louisiana coast, the mobile drilling unit Deepwater Horizon exploded, caught fire and sank. In addition to the spilled oil, some response activities negatively impacted sandy beaches and marshes.

Coastal sandy beach habitat was subject to oiling as well as disturbance from spill response activities. Among other services, Gulf beaches support critical ecosystem functions by providing nesting habitat for beach nesting birds. Undisturbed stretches of beach are key components required for the life cycle of many species; however, many types of disturbance are common on Gulf beaches. When people and their pets enter nesting areas beach nesting birds are disturbed, potentially resulting in nest abandonment, egg loss, and chick mortality. Posting important nesting areas has been shown to effectively reduce human disturbance of nesting sites. In addition to human disturbance, predators (e.g., coyotes, raccoons, foxes, feral cats) of beach nesting birds also pose a significant threat to nest success in some of the project areas. Reduction of predator populations can measurably increase nest success.

As part of the DWH NRDAR program the Trustees are implementing restoration projects to help address injury to nesting habitat for beach nesting birds by mitigating disturbance on nesting beaches at Bon Secour and St. Vincent National Wildlife Refuges in Alabama and Florida, Gulf Islands National Seashore's Mississippi and Florida districts, and on Alabama and Florida state beaches.

This project uses three techniques: 1) placing symbolic fencing and warning signs around sensitive shorebird nesting sites to indicate the sites are off limits to people, pets, and other sources of disturbance, 2) increasing predator control by non-lethal and lethal methods consistent with current management practices to reduce disturbance and loss of eggs, chicks, and adult beach nesting birds at nesting sites, and 3) increasing surveillance and monitoring of posted nesting sites to minimize disturbance to beach nesting birds in posted areas. Fenced nesting habitats are being monitored to support adaptive management practices and responses (e.g., if beach nesting birds shift nesting site locations, posting materials are relocated accordingly), and to gather data needed to quantitatively evaluate the effectiveness of the project. These actions are occurring on approximately 1,800-2,300 acres of nesting habitat.

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STREAM RESTORATION DESIGN – ECOLOGICAL RESTORATION AND TMDL COMPLIANCE

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In the Chesapeake Bay region, stream restoration design projects are gaining popularity as a preferred BMP for municipalities to help meet their regulatory compliance goals associated with the Chesapeake Bay TMDLs and MS4 permits. The use of stream restoration projects to meet TMDL compliance is also gaining traction and being investigated in several other states outside the Chesapeake Bay region. Stream restoration projects provide added benefit to communities as they not only provide significant water quality benefits but also provide an opportunity to integrate public amenities into the design such as greenways and trails, and also provide opportunities to improve aquatic and terrestrial habitat.

This presentation will discuss a stream restoration project to be constructed in the summer of 2014 in Richmond, VA. The stream restoration will follow the natural channel design method, which addresses the entire stream system and is based on fluvial geomorphology to create a stable channel that maintains a state of dynamic equilibrium. The stream project is located on property owned by the City's Parks and Recreation Department. The park is currently under utilized and does not have a maintained trail system. The project will help the City of Richmond meet regulatory compliance goals by achieving pollutant load reductions based on efficiencies that have been developed for the Chesapeake Bay from the Expert Technical Panel for stream restoration projects. Based on the design criteria, it is estimated that the restoration project will result in the removal of 532 lbs/year of phosphorous and 24,273 lbs/year of sediment while also providing a trail system (walking and bike path), and improving the aquatic and terrestrial habitat along the stream channel.

The restoration design will also include a trail system (walking and bike path) that will provide the City with added opportunity for public outreach and education and will coordinate with the City's goals for greenways and expansion of a municipal trail system. The restoration of the stream will also improve habitat (fish and wildlife) and reconnect the stream to the floodplain. Improving stream channel dimension, pattern, and profile will improve channel flow efficiency, reduce erosion, and create a floodplain that allows for additional habitat features.

The planning, design and construction process will be discussed in the presentation along with a how this project achieves increased aquatic and terrestrial habitat and fits into the City's TMDL compliance plan and pollutant reduction strategies.

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THE ISLANDS OF THE DELAWARE RIVER: USING GIS TO PRIORITIZE RESTORATION AND CONSERVATION EFFORTS

Carol M. Maxwell *and Ben Gardner*
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The Delaware River is the largest undammed river east of the Mississippi, providing drinking water for 5% of the United States population as well as a unique network of ecological services for the surrounding areas. A wealth of aquatic species populates the channel, and avian species migrate and nest along its length. These species move between the remaining natural areas that are threatened on both sides by dense urban development, farms, industrial areas, and sprawling suburban centers between the states of Pennsylvania, New Jersey, and Delaware. Paramount to use of the river as a corridor for many species are the islands of the Delaware River. These landmasses within the river have been explored and altered by humans, many having notable historical and archeological value to our species (Delaware River Keepers, 2010).

This combination of ecological and cultural value is impetus for action. Spanning four states, these threatened assets are the concern of a myriad of conservation groups. It is a setting thoroughly complicated by political boundaries, ultimately to the detriment of the ecosystem and all it provides. The huge corridor that is made up by the islands of the Delaware River is in need of a comprehensive action plan that transcends these barriers and aids in its conservation and restoration. The islands inherently have varying potential for conservation due to their location within the corridor, the resources documented, and possible political hurdles as well as human impacts both in the past and in the modern era, among other factors (Randolph, 2012). Losing or further fragmenting what remains of the connected river corridor could cause catastrophic damage to all species as well as the river's water quality.

The authors of this study have used GIS to compile existing data on the islands concerning specific habitat, types of ecosystems present, dredging history, slope, ownership, land cover, landuse and many other factors. Then, utilizing Paul Beier's work on *Designing Wildlife Corridors* and *Linkage Design*, the authors have weighed the ecological value of each island versus the biological threat to combine the many layers of available data and systematically prioritize which islands are threatened, ripe for conservation, and in need of restoration.

The process has yielded both geographically significant datasets that may be distributed and improved upon by proximal communities as well as the beginnings of a unified system of corridor area prioritization for the Delaware River. The system weighs practical features such as accessibility and ownership, the relationship of the island to its surrounding areas, and the sensitive ecological and historical value present on these islands. With the Delaware River as a major ecological corridor and the islands the stepping-stones, this study explores one planning tool in the design of a healthy wildlife corridor according to current constraints and values.

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ERIE MARSH PRESERVE COASTAL WETLAND RESTORATION

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Erie Marsh Preserve in western Lake Erie includes 945 acres of Great Lakes coastal marsh within a system of dikes constructed during the 1950s. This project will ultimately restore and enhance the 945 acres of coastal wetlands in 10 independent management units through the construction or improvement of dikes, distribution canals, water control structures, and the installation of a new water supply system and fish passage structure. In 2012, the fish passage structure was completed, restoring a hydrologic and physical connection between Lake Erie and the managed dike portion of Erie Marsh Preserve following 60 years of separation. The diked wetlands are critically important for spring, fall, and winter staging, feeding, and resting of waterfowl and other wildlife, as well as home to unique plants. The improved infrastructure will provide capacity for long-term, adaptive management of a high-quality coastal wetland complex and control of invasive *Phragmites*. Pre- and post-restoration monitoring includes water quality, fish, birds, herpetofauna, and vegetation. The presentation will include details of the site design and operation, climate-wise features, pre-restoration monitoring results, as well as preliminary results from some components of post-restoration monitoring. Project partners include U.S. Fish and Wildlife Service, Ducks Unlimited, Michigan Department of Natural Resources, and the Erie Shooting and Fishing Club; project funding has been provided by National Oceanic and Atmospheric Administration and National Fish and Wildlife Foundation.

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EARLY DAYS OF SHRUBLAND REHABILITATION IN AN ARID COASTAL SETTING: INSIGHT GAINED THROUGH PILOT PROJECTS AND TRIAL AND ERROR AT A SEA SALT FACILITY IN WESTERN AUSTRALIA

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Shrubland rehabilitation in arid and semi-arid settings is challenging even under favourable environmental conditions. Successful rehabilitation requires knowledge of many inter-related biotic and abiotic factors, means for alleviating factors that impede success, and the willingness to learn from small-scale pilot projects, trial and error, and failure in some cases. Shark Bay Resources, a solar sea salt facility in Western Australia, is increasing its capacity to rehabilitate land degraded as part of seawall, levee, and haul road construction and maintenance by better understanding: (1) cost effective earthworks and site preparation procedures, (2) differences in substrate types and their ability to support vigorous plant growth, (3) seed collection, cleaning and storage, sowing approach and rate, and optimal depth of burial, (4) container-grown stock as a means for including recalcitrant species difficult to collect seed from or grow from seed, and (5) realisation that rehabilitation response times in arid settings may be longer compared to high rainfall zones, requiring timelines and expected outcomes to be realistically established.

Over the past two years we have demonstrated the importance of substrate de-compaction as it pertains to infiltration, moisture retention, and root growth. We have also shown the value of topsoil relative to deeply-sourced subsoil for seed germination and seedling emergence, and that seeding with a combination of dormant and non-dormant seed increases the overall number of germination and emergence events, but not necessarily seedling establishment. Mechanical seed sowing, as opposed to hand broadcasting, has benefited seed delivery, and proper seed burial has improved seed germination and the loss of seed resulting from aeolian transport and predation. Although the use of container-grown stock in arid settings can be especially challenging because of moisture stress, we have observed moderately good survival by using properly hardened-off stock, well-timed installation with respect to soil moisture content, one-off watering events, and through low-level slow-release fertilisation formulated for native species.

Although early in the rehabilitation process, the combined direct seed and container-grown stock approach being researched at Shark Bay Resources has been very insightful despite two years of below average rainfall. We feel what we have achieved thus far benefits arid coastal shrubland rehabilitation and ecological restoration in general where many limiting factors may be poorly understood. By increasing its rehabilitation capacity and ability to restore degraded land, Shark Bay Resources is directly benefiting the ecological integrity of the surrounding World Heritage Area whilst serving as a good corporate citizen.

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AN ALTERNATIVE METHOD FOR OFFSHORE REVETMENTS

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Shoreline erosion is a significant issue throughout the country, especially in light of sea level rise. Aside from the loss of property for both public and private entities, sediments migrating into receiving waters increase turbidity and potential for contaminant distribution. Historically, bulkheads and rip rap revetments were used to reduce the impacts to land. These structures are effective, only to a degree. Bulkheads are subject to failure due to infestation, but more common in higher wave energy environments, scour causes the structural degradation of the bulkhead. Rip rap is more effective in preventing loss of upland, but has constraints. In many cases, achieving the correct angle of repose for the seaward face requires significant excavation of upland. The alternative to fast land excavation is to impact beach, intertidal or subaqueous bottom. If not properly constructed, additional stone must be placed over the sloughing structure. As a result, oyster strike and other colonized biota may be displaced along with additional impact to the habitat at the toe of slope.

Offshore revetments provide shoreline protection while not generally requiring manipulation of uplands. The exception to this would be areas that exhibit escarpments or critical slopes. In these cases, it is better to reduce the angle of repose for these adjacent lands. Offshore revetments are not designed to accept major storm surges and often are overtopped in these cases. However, under normal conditions, they are effective in reducing shoreline erosion. The normal procedure is to design the structures so that they are positioned to reduce wave energy prior to the original shoreline. In most cases, a tombolo is constructed behind the revetment. This creates additional beach habitat and assists in the structural integrity of the overall structure. Tombolos are susceptible littoral drift and can degrade over time and may need to be nourished. In the Tidewater Area of Virginia, stone is expensive and must be brought in for construction of these structures.

We were tasked by a client group to find an alternative to stone, that was more affordable. We researched and found Living Shoreline Solutions Inc. and their product known as a Wave Attenuating Device (WAD). The cost of this concrete product was significantly less, while affording the same protection as stone. We deployed the system by barge in September of 2012. In October of 2012, Hurricane Sandy hit the East Coast. As part of our monitoring requirement we surveyed the post storm project area and the annual survey in September of 2013. While Hurricane Sandy had a storm surge of approximately five feet above normal high water, the associated shoreline's erosion was significantly reduced and the WAD arrays remained intact. The annual survey demonstrated significant accretion of sand behind the arrays, causing a significant seaward migration of Mean Low and High Water. While the survey data are limited, we have not seen this amount of sand accretion with any other structures.

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22 YEARS OF WORLDWIDE REEF BALL COASTAL RESTORATION

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As a result of natural disasters and human impact, coral reefs, marshes, oyster beds, mangroves and other marine habitats are in need of preservation and restoration. Worldwide there has been a significant loss of marine ecosystems.

Research has shown a need to: increase juvenile fish habitats, increase oysters in estuaries, protect shoreline, increase sediments in marshes. Reef Balls® were selected for the projects because: the design and testing of the product demonstrated the quality and characteristics to meet project needs. Reef Balls utilize pH balanced, marine-grade concrete, with a textured surface and without environmental toxins. Reef Balls® were designed to mimic natural ecosystems. Reef Balls® have a history of staying where they are placed.

The process involved a site survey, permitting, deployment and monitoring of the modules. Reef Balls have been placed in various ecosystems around the world. The success of Reef Balls has been demonstrated over the past 22 years with projects in over 60 different countries. Studies and analysis of data collected from numerous sites have shown Reef Balls to be an excellent material for: fish habitat, mangrove restoration, breakwater for beach stabilization and nourishment, oyster bed development, coral transplanting and preservation, as well as the reestablishment of living shorelines.

Reef Balls have been successful in meeting the objectives of marine restoration projects around the world.

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WILDLIFE RESPONSES TO LONGLEAF PINE HABITAT STRUCTURE RESTORATION

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One of the long-term objectives of the America's Longleaf Restoration Initiative (ALRI) is to increase the acreage of high quality habitat for the unique wildlife communities associated with longleaf pine ecosystems. These open-canopied forests with grass-dominated understories are maintained by frequent, low-intensity fire and provide preferred habitat structure for 29 Federally-listed species in addition to many other species of conservation concern, both animals and plants. As part of the overall longleaf restoration efforts, several groups are collaborating to develop and refine detailed parameters of desired habitat structure for longleaf-associated wildlife. This habitat structure helps define the category of "maintenance condition" articulated in the rangewide conservation plan (RWCP) for longleaf pine.

One of the primary vehicles for implementation of the RWCP is the Longleaf Stewardship Fund (LSF), administered by the National Fish and Wildlife Foundation (NFWF). This grant program provides funding for Local Implementation Teams to carry out on-the-ground restoration of longleaf pine ecosystems. To refine implementation of the LSF, in 2012 the Joseph W. Jones Ecological Research Center, NFWF, U.S. Fish and Wildlife Service, NatureServe and the Alabama Cooperative Fish and Wildlife Research Unit collaborated on a project to synthesize current understanding of preferred habitat for longleaf species of conservation concern. The primary goal of this initial project was to help NFWF better prioritize proposed LSF projects to maximize wildlife responses to restoration actions.

Literature surveys, synthesis of recent and ongoing related projects, and expert opinion were used to propose desired ranges for structural elements of vegetation for longleaf-associated wildlife including basal area, canopy cover, midstory cover and understory cover and composition. Four wildlife species were identified for preliminary analysis; Bachman's sparrow, Northern bobwhite quail, gopher tortoise and red-cockaded woodpecker. Common elements of preferred habitat structure were synthesized and used to parameterize a prototype Bayesian decision support tool in the Netica® software program. Other elements incorporated in the model were a state transition matrix that characterized changes in forest structure through time, common restoration treatments and their costs, and landscape context (proximity of conservation land, source populations). This work moves beyond a generic goal of establishing more acres of longleaf by incorporating structural objectives that benefit longleaf-associated wildlife in assessment of LSF projects. This will be an ongoing, adaptive process that incorporates new information on wildlife responses to longleaf restoration. Further research by several groups is underway to develop more detailed understanding of wildlife responses to longleaf habitat structure.

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VISUALIZING CLIMATE CHANGE SCENARIOS FOR FLORIDA'S RESTORATION AND CONSERVATION EFFORTS

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The Peninsular Florida Landscape Conservation Cooperative (PFLCC) is part of a nationwide network of LCCs focused on bringing together public and private agencies and organizations of scientists, stakeholders, and decision-makers to inform conservation strategies and improve resource management decision-making on a regional level. Sea level rise over the next 50 years and beyond has the potential to disproportionately affect the State of Florida due to its low and generally flat elevation. The range of potential impacts due to climate change on the State's ecosystems must be carefully analyzed and considered if appropriate action is to be taken. A team of federal, state, and private scientists organized by the PFLCC has begun generating predictive modeling scenarios on a statewide scale that vary based on sea level rise, policy decisions, human population growth, and financial resources. Numerous supporting datasets are also being used by the PFLCC modeling effort which include: inundation modeling of a 100-year event with and without sea level rise on 3 select counties; an update to the Critical Lands and Waters Identification Project (CLIP) database; and niche models for Florida's threatened and endangered vertebrates under future climate conditions. USGS scientists working under the Joint Ecosystem Modeling (JEM) collaborative umbrella have been asked to develop a visualization solution that allows users to see and interact with the various datasets used by the PFLCC effort.

The EverVIEW Data Viewer application has been used as a decision-support visualization tool in restoration and planning efforts such as the Central Everglades Planning Project (CEPP) and the State of Louisiana's 2012 Coastal Master Plan. Through these and other projects, EverVIEW has matured into a platform upon which extensions could be built, allowing more customized interaction with certain datasets. As a freely available, extensible visualization platform targeting a non-technical audience, EverVIEW was a natural fit for the predictive modeling visualization challenge.

The PFLCC Scenarios Viewer extension was designed to make the process of locating and loading data along with configuring EverVIEW to visualize the predictive scenarios easy for the end user. The extension sets up the EverVIEW environment and automatically retrieves and loads the three statewide scenarios. Users can easily swap out one of the statewide scenarios for one of the county-level inundation datasets under a 100-year event with 1 meter sea level rise, or any of the other modeled datasets. Polygons for state counties and conservation areas are also bundled with the tool to allow comparison of specific regions under different conditions.

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INFORMING WATER MANAGEMENT DECISIONS IN LARGE SCALE RESTORATION PROGRAMS: THE USE OF ECOLOGICAL MODELS IN THE EVALUATION OF PROJECT PLANS

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In its third biennial review of progress towards Everglades restoration, the National Research Council's Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP 2010) concluded that concluded that "Improved species models… are urgently needed to provide more rigorous scientific support for water management decisions". During the recent (2013) Central Everglades Planning Plan (CEPP) process, which was a U.S. Army Corps of Engineers pilot project for expedited restoration planning, several ecological planning tools, or models, were used to quickly visualize and evaluate alternative project plan effects on Everglades wildlife and vegetation.
Efforts to employ ecological models and/or habitat suitability indices in Everglades restoration planning reach back to the mid-1990s and the formulation of the Comprehensive Everglades Restoration Plan (CERP). In the intervening years, an increasingly rich data set from field monitoring and research, funded through RECOVER's Monitoring and Assessment program as well as other agency and non-agency partners, has allowed for the development of much more sophisticated tools. The ecological models used in CEPP planning provided a strong linkage to the ecological effects of alternative plans from simulated hydrology.

The ecological tools used in CEPP included effects on the ecology of oysters, submerged aquatic vegetation in both the northern and southern estuaries, American alligators, apple snails (as a proxy for the Everglade snail kite), wading birds (Great Egret, Wood Stork, White Ibis), Everglades landscape vegetation, marl prairie habitats, prey fish and large fish (bass), spotted seatrout, juvenile crocodiles and pink shrimp. The results of these models in project planning were used to evaluate and refine project alternatives and determine the effects of the final plan on these natural resources.

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ENGINEERING AND DESIGN MID-BARATARIA SEDIMENT DIVERSION PROJECT

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The Coastal Protection and Restoration Authority (CPRA) is charged by the Louisiana State Legislature with combating and reversing short and long-term land loss trends. Causes for land loss include, but are not limited to, subsidence, sea level rise, oil and gas operations, isolation of the bays and estuaries from Mississippi River sediments and storms events. The Louisiana Comprehensive Master Plan for a Sustainable Coast (2012 State Master Plan) lays out CPRA's implementation plan for coastal protection and restoration. Re-establishing sediment rich water connections between the Mississippi River and Louisiana's bays and estuaries is one of the highest priorities of the 2012 State Master Plan. The Mid-Barataria Sediment Diversion Project (MBSD) is identified in the Plan as a large-scale, long-term restoration feature recommended for re-establishing a direct connection between Barataria Basin and the Mississippi River. MBSD will provide sediment to the Barataria Basin to create land, sustain coastal wetlands, counteract subsidence and help to restore and rebuild the Louisiana coast. CPRA has been working with federal, state and local entities since 2001 to define the size, location and benefits associated with a large diversion project in the vicinity of Myrtle Grove, Louisiana.

Results of preliminary investigations determined that the optimum location for the diversion project is in Plaquemines Parish on the west bank of the Mississippi River in the vicinity of the town of Ironton, LA. The river intake will be located at mile marker 60.7 Above Head of Passes; with the desired performance of conveying 75,000 cfs sediment laden water when the river stage is running in excess of 1,000,000 cfs. The constructed project will reestablish a connection between the river and estuarine system to build and maintain critical costal wetlands. An adaptive management plan will be developed to manage the operations of the project to allow variable flow rates to respond to seasonal, sediment and outfall area conditions, thus maximizing sediment transport for restoration potential while minimizing potential negative effects.

In December 2012 CPRA awarded a contract to HDR Engineering to perform planning engineering and regulatory services for the MBSD project to deliver a constructible project. Services provided by the HDR design team include complex modeling, geotechnical, surveys, engineering design, plans and specifications, operations plan, land rights investigation, , permit development and submittal, monitoring plan, outfall management planning and recommendation , opinion of probable construction cost, maintenance plan, public outreach and project administration. This discussion will focus on the progress to date and the expected path forward for this complex and complicated project

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PLAQUEMINES PARISH PROGRAMATIC RIDGE RESTORATION, DESIGN, AND MANAGEMENT

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Plaquemines Parish, Louisiana will suffer from some of the highest rates of subsidence and sea level rise over the next century. A decision criteria based on numeric analysis was formulated to select remnant distributary ridge projects which would have the most effect of increasing levee resiliency by reducing wave energy while simultaneously restoring former natural ecosystem features. In order to combat the continual threat of monetary damages caused by hurricane storm surge flood over topping of its protection levees coupled with high rate of wetlands loss resulting from accelerated sea level rise and subsidence, ARCADIS has been tasked with the programmatic management and design analysis aimed at restoring remnant forested ridges which are artifacts of previous Mississippi River distributaries in southern Plaquemines Parish. The project's goal is to increase the protection levees' resiliency through reducing the wave over topping rates and wave energy at the levee face. The project will accomplish these goals by restoring the historic ridge remnants to the height and vegetation level required to sufficiently dissipate the wave energy experienced by the protection system. Besides high rates of subsidence and sea level rise, the project's design is further complicated by the poor underlying soils, limited local borrow availability, and permitting issues associated with converting, in some places, functioning brackish marsh habitat into an upland environment. The ARCADIS team analyzed several potential project alternatives proposed both by the team internally and by the parish. Ultimately, ARCADIS formulated a decision criteria used to select projects which would have the most effect in reducing wave energy while simultaneously restoring former natural features of the local ecosystem.

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IMPACTS OF EXOTIC EARTHWORMS ON PLANT COMMUNITIES: IMPLICATIONS FOR RESTORATION AND INVASIVE SPECIES MANAGEMENT

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Exotic earthworms have invaded much of eastern North America and can have dramatic impacts on ecosystem structure and function. Through modifications of abiotic properties of the soil environment and by acting as seed predators, seed dispersers, and granivores, earthworms can both indirectly and directly influence plant growth. These earthworm-plant interactions are complex and may have mixed positive and negative impacts on different plant species – including vulnerable at-risk species and aggressive invasive species – potentially resulting in large-scale community-level change in invaded ecosystems. Field and experimental studies of these interactions are lacking, and the effects of earthworms on efforts to manage or restore natural areas remain largely unknown.

The first objective of this project is to gain a better understanding of how earthworm-plant interactions structure plant communities. The second objective is to examine how these earthworm effects may influence the outcomes of restoration and invasive species management projects. This project is focused on restoration efforts in southern Ontario, Canada and on the impacts of the prominent invasive earthworm Lumbricus terrestris. A range of earthworm-invaded and earthworm-free meadow and forest locations that had undergone previous restoration were selected. For each past restoration project, characteristics of the pre- and post-restoration plant communities and the relative success of the restoration were compared to the abundance, spatial distribution, and species diversity of earthworms within and between sites. These field studies were supplemented by a greenhouse mesocosm study examining the effects of earthworm presence-absence on single- and multi-species assemblages created using standard restoration seed mixes and invasive plants of concern in southern Ontario, including Alliaria petiolata and Ambrosia trifida. Overall, the presence of earthworms was found to selectively favour the growth of certain plant species over others, suggesting that some plants used in past and prospective restoration programs may indeed be more or less suitable depending on whether earthworms are present.

Management options against exotic earthworms are limited; it is important to recognize earthworms as novel ecosystem components that are here to stay. Thus far, conventional restoration and management practices have largely ignored this increasingly common and highly influential taxon. Understanding which desirable and undesirable species are particularly impacted by earthworm activity – either positively or negatively – may improve our ability to design efficient and effective restoration strategies for the rapidly-growing global number of earthworm-invaded ecosystems.

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RED BUG SLOUGH ECOSYSTEM RESTORATION

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Red Bug Slough Preserve is a 72-acre natural preserve completely surrounded by residential and commercial development in north central Sarasota County, Florida. It is highly prized by the community as valuable green space with amenities such as hiking trails, bird watching, a small playground, picnic shelters, and a fishing dock enjoyed by area residents and visitors year round. Red Bug Slough, with headwaters originating outside of the preserve in Mirror Lake, flows through a series of inter-connected lake systems into and through the preserve to Phillippi Creek, a major tributary to Roberts Bay North. Significant alterations have been made to the slough since 1948, and it has been documented that about 74% of the 380 acres of herbaceous wetlands have been lost.

The Florida Department of Environmental Protection (FDEP) determined the slough system to be impaired for nutrients and adopted a Total Maximum Daily Load (TMDL) for chlorophyll. Water quality monitoring confirmed that a sizeable bird colony located upstream in Mirror Lake contributed significant amounts of nitrogen and phosphorus to the slough; and therefore, functioned as a natural nutrient source. It was determined that the restoration of historical wetlands located in the preserve could provide treatment and improve the quality of water transported by the slough to the bay.

Three main restoration areas were identified: Segment A is an open drainage ditch that delivers minimally treated stormwater runoff directly to the slough; Segment B is an isolated, historical marsh that is overgrown with exotic species and has no significant hydrologic or habitat value; Segment C consists of three disconnected, isolated marshes that are also overgrown with exotics and have no significant hydrologic or habitat value. The project was designed with the goals of restoring and enhancing a portion of the historical marshes; improving water quality treatment to increase nutrient removal; removing exotic vegetation; preserving existing native habitat; increasing aquatic habitat; restructuring the shoreline to recreate littoral shelves for water quality treatment and habitat improvement; and enhancing recreational use. It is scheduled for completion in January 2014.

The presentation will provide an overview of the project from design through construction as well as problems encountered, problem resolutions, project results, and lessons learned.

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POST-RESTORATION ECOSYSTEM SERVICE EVALUATION OF A SEASONALLY CLOSED ESTUARY: MALIBU LAGOON CASE STUDY

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Historically, many southern California estuaries exhibited seasonal closure patterns through the development and deposition of sand berms in dry seasons and subsequent erosion and removal during wet season storms; however, recent restoration efforts have focused on the creation of perennially open estuarine systems. Malibu Lagoon is a 16-acre shallow water estuarine wetland located at the base of the Malibu Creek Watershed, a relatively undeveloped watershed in Los Angeles County. The Lagoon was one of the few southern California restoration projects to preserve historic seasonal closure dynamics. The scope of the restoration project included increasing wetland acreage, removing excess sediment and re-contouring channels to increase tidal and wave driven water circulation, and decrease rates of sedimentation. The restoration was designed to enhance ecosystem services including environmental services such as improved water quality, flood protection, and habitat for rare species, as well as socio-economic services such as educational interpretive panels, bird viewing platforms, and ADA compliant walkways.

This paper presents a comparative analysis of pre- and post-restoration baseline monitoring data and evaluates the project's initial success and ecosystem service benefits against fixed restoration goals. Data collected included: water quality, vertical water quality profiles, California Rapid Assessment Method (CRAM), vegetation cover, avifauna, ichthyofauna, and channel cross-section profiles. Post-restoration success was determined primarily through water quality and hydrological indicators, the results of which suggested well-mixed water columns with an increase in overall dissolved oxygen and circulation leading to better habitat for several endangered fish species such as the Tidewater Goby (Eucyclobius newberryi) and Steelhead Trout (Oncorhynchus mykiss). Current post-restoration data show improvements across a broad range of ecosystem and economic services including higher biodiversity, improved water quality for both beachgoers and wildlife, increases in productive wetland and rare species habitat, and a platform for wetland education.

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LOWER MISSISSIPPI RIVER SEDIMENT DIVERSIONS AND DEDICATED DREDGING: ADVANCEMENT IN NUMERICAL MODELING

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There is a dire need to use sediment from alluvial rivers to sustain and create new marsh, sustain barrier islands and ridges. Coastal Louisiana is a prime example where wetland loss rates are one of the highest worldwide. This study discusses the sediment dynamics of the Lower Mississippi River, specifically the sediment availability, temporal and spatial variability, as well as the sediment size characteristics. The investigation is performed using morphodynamic numerical tool (Delft3D).

The Louisiana 2012 State Master Plan identified two viable mechanisms to build land, sediment diversions and dedicated dredging. The morphodynamic model will be parameterized and validated using historical and recent field observations. The model is being used to investigate the riverside morphological response to single or multiple dredging of lateral sand bars as well as the infilling pattern and rate. The model will also be used to identify the key design parameters that govern the sediment capture efficiency of sediment diversions, e.g. the alignment angle, invert elevation, diversion size, and location.

The uncertainty and limitations in the ability of the numerical model to adequately capture the relevant physical processes is discussed. The implications of such limitations on the decision making process is presented.

Despite the limitations and uncertainties, the study provides valuable design recommendation for sediment diversions to maximize their sediment capture efficiency. The study also provides a management plan for dredging multiple borrow areas. The management plan includes coordination of dredging timeline among multiple borrow pits, as well as coordination between dredging activities and sediment diversion operation plans.

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MISSISSIPPI RIVER HYDRODYNAMIC STUDY: UNDERSTANDING SEDIMENT AVAILABILITY AND DELIVERY FOR LAND BUILDING

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Land loss in coastal Louisiana remains to be a challenging problem to address. Sediment Diversions and dedicated dredging are restorations strategies to combat the wetland loss in coastal Louisiana. The objectives of this study include identifying suitable diversion locations and the critical factors governing such selection; investigating efficient operation regimes to capture proportionate amount of water and sediment; providing general guidelines on how to convey the captured sediment to the receiving basin, and assessing the potential morphological impact of sediment diversions on the river channel. The study also investigates the land building potential and delta growth in the receiving basin side along with impacts on the vegetation composition and nutrient dynamics. Further, the study investigates sediment recharge of borrow pits and the possible frequency of dredging of sand bars.

Detailed field observation program in the river and receiving basins along with extensive numerical modeling are used to perform this study. Data collection in the river will focus on the velocity field, multi-beam bathymetry, suspended sediment load, bed load, and bed grain size distribution. In the receiving basin, the field observations include bulk properties, grain size and organic content, strength profiles, substrate stratigraphy profiles, and erodability and loading coefficients. The numerical modeling will be done using the open-source three-dimensional morphodynamic Delft3D model.

The numerical models will provide insights for a single or multiple diversions operating simultaneously. They will provide short term (single flood event) and long-term (20 to 50 year) assessment of each individual diversion and how sea-level rise and subsidence might impact the efficiency of capture and delivery of sediment to the receiving side. These numerical tools can also: provide critical information regarding the long-term and large-scale (ten to hundred river miles) impact of each individual diversion on the morphology of the river channel (e.g., stability of lateral sand bars, shoaling, etc.); assess the hydrodynamics in the river during diversion (single or multiple) operations to determine effects on navigation; and provide insight into the coordination and management of the full suite of diversions and their land building potential in the receiving basin.

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URBAN GRASSLANDS: STRATEGIES FOR VACANT LOTS AT THE CITY SCALE

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Across many urban areas in the United States and Europe vacant or blighted property is a major hindrance to the stability of neighborhoods and communities. Real estate values, community cohesion, health and safety concerns are all affected by the condition and presence of vacant and blighted properties. Vacant lands also require significant municipal resources to maintain and manage these properties, which is a drain on resources that might be spent building communities.

However, vacant lands can be a vital part of the urban ecosystem and provide a range of environmental services. These landscapes offer the potential for increased carbon sequestration, decreased nitrogen runoff, stormwater storage and cleansing, reduced heat island effect and increased biodiversity and habitat.

One of the goals of this study is to investigate the link between the social and economic issues surround these vacant lands, such as public perception, real estate stabilization, neighborhood cohesion, maintenance and management costs, and the ecological function of these urban environments. This pilot study in New Orleans investigates techniques for increasing the ecological function of these lots in relationship to these social and economic contextual factors. The study test plots consist of 24 vacant city lots in two neighborhoods that have a large percent of blighted or vacant property. In each lot we are looking at different options for restoring a novel grassland ecosystem or a novel urban forest ecosystem. These lots will be planted in early 2014 and monitored over the following 3 years.

The initial variables include a range of site preparation techniques compared with establishment success and cost of implementation. A longer term study of the maintenance and management implications will be conducted over the following two years. The neighborhood perception of these novel ecosystem approaches will be monitored as well to understand the cultural acceptance of these landscapes in the city.

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FRESHWATER RESTORATION OF TIDAL SWAMPS: LESSONS FROM REMEDIATION DURING THE DEEPWATER HORIZON INCIDENT

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Coastal freshwater wetlands can be impacted by elevated salinity because of upstream hydrologic alteration, sea level rise and tidal inundation. In particular, decreased freshwater supply along coastal rivers and streams is becoming a key conservation and restoration issue. In Big Thicket National Preserve (BTNP) in Texas, trees in coastal freshwater forests began to die in the high salinity environments related to the drought of 2012. At the same time, hydrological remediation to push oil offshore during the Deepwater Horizon Incident in Louisiana gave some insight into how salinity stress in coastal forests might be reduced along altered streams and rivers. We have documented long-term production processes in coastal baldcypress swamps in Jean Lafitte National Historical Park and Preserve (JLNHP&P) in Louisiana and BTNP. From 2010-2012, tree growth increased after the freshwater flow rate was increased for several months through the Davis Pond Diversion structure north of JLNHP&P during the oil spill emergency in 2010. The study suggests that freshwater releases may be essential to the restoration and management of tidal baldcypress swamps. This project was funded by National Science Foundation RAPID award and the U.S. Geological Survey Ecosystems program.

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MOLECULAR AND CYTOLOGICAL IDENTIFICATION OF CATTAIL TAXA IN NATIONAL PARKS

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Cattails (*Typha* spp.) have become a dominant plant group in wetlands across North America during the past 150 years. There are three recognized species in North America: *Typha latifolia* L. (broadleaf cattail), *T. domingensis* Pers. (southern cattail), and *T. angustifolia* L. (narrowleaf cattail). Recent studies have shown that hybridization of *T. latifolia* and *T. angustifolia* has occurred in the Midwest national parks and in California. *T. angustifolia* is considered to have entered the east and west coast of the U.S. via ship ballast during the mid-1800s. However, it was not until the mid-1950s that molecular techniques using isozyme analysis were developed to identify parental and hybrid taxa. More recent molecular methods have allowed more accurate identification of cattail taxa using DNA markers called microsatellites.

Since 2005 we have applied microsatellite analysis to identify cattail taxa in selected sites in 6 western Great Lakes national parks and in a California national park. Results indicate that the proportion of parental and hybrid taxa is highly variable across the US. The highest frequency of both F1 and backcross hybrids occurred in Indiana Dunes National Lakeshore (Cowles Bog), with no detection of parental taxa. At Point Reyes National Seashore in California, hybrid taxa were also present at the three sampled sites. The trajectory of hybridization supports earlier investigations that used herbarium specimens to show invasion of *T. angustifolia* at both east and west coast entry points.

Cytological analysis of cattail pollen was also used to determine if this method could be used to identify cattail taxa. We collected pollen samples from northern Indiana wetlands and used a simple staining procedure and microscope to evaluate the pollen types. *T. latifolia* has tetrad pollen, whereas *T. angustifolia* has monad pollen. Hybrids have mixed pollen types. We used a simple scoring technique on pollen slides prepared from individual plants based on presence or absence of pollen types. We were able to determine the percentage of plants showing parental or hybrid pollen. This method could offer managers a relatively rapid way to evaluate cattail populations for management purposes. Confirmation with both molecular and cytological techniques offers optimum identification of cattail taxa.

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CAN THE USE OF SURROGATE WRACK PROMOTE SURVIVAL AND GROWTH OF PLANTED *UNIOLA PANICULATA* AND DUNE BUILDING?

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The increasing number of stresses on coastal dune ecosystems requires the use of more effective restoration strategies to enhance dune-building and increase vegetation reestablishment. The use of a wheat straw as a surrogate wrack was an effective method to improve growth of spring planted *Uniola paniculata* (sea oats). Approximately 1000 *U. paniculata* plugs were planted within 21 × 4 m plots at six replicate sites. Two weeks later, plantings were divided into 11 × 4 m subplots with half of the subplots receiving five bales of wheat straw and the remaining subplots receiving no wheat straw. This surrogate wrack layer measured approximately 10 cm in depth. Mean aboveground biomass of *U. paniculata* six months after planting with surrogate wrack was 9.25 g ± 1.00 g compared to 2.18 g ± 0.24 g without surrogate wrack. Number of tillers, tiller height, and basal width were also greater at the end of the first growing season for plants treated with surrogate wrack ($p<0.05$).Two years after planting, significantly more inflorescences occurred and aboveground biomass (g/m^2) was greater with than without surrogate wrack. Sand accumulation was notably greater with surrogate wrack (11.16 cm) than without wrack (7.78 cm) eight months after planting ($p=0.1093$). Relative sand accumulation was greater (18 cm) with surrogate wrack compared to without surrogate wrack ($F_{1,5} = 7.91$ $p= 0.0374$) two years after planting. Increased sand accumulation suggests surrogate wrack either directly or indirectly traps more sand by creating an additional obstacle or promoting the growth of dune grasses.

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NATURE-BASED FEATURES IN A SYSTEMS APPROACH TO COASTAL STORM RISK MANAGEMENT

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The North Atlantic Coast Comprehensive Study is being undertaken as part of the many efforts underway in the US Army Corps of Engineers (Corps) Hurricane Sandy recovery program. The Comprehensive Study will provide a Risk Reduction Framework, consistent with Infrastructure Systems Rebuilding Principles advanced by the Corps and the National Oceanic and Atmospheric Administration in February of 2013. The Comprehensive Study seeks to support Coastal Resilient Communities and sustainable coastal landscape systems, considering future sea level rise and climate change scenarios, to reduce risk to vulnerable populations, property, ecosystems, and infrastructure. Working in partnership with other Federal Agencies, States, Tribes, local governments, academia, non-governmental organizations and regional stakeholders, the Comprehensive Study is developing tools and methodologies for a systems approach to coastal storm risk management.

A systems approach to coastal storm risk management evaluates the full range of risk reduction measures (structural, non-structural, and natural/nature-based features (NNBF)) in an integrated approach to risk reduction. This presentation will describe the Corps' collaborative efforts to define performance metrics for NNBF that provide the basis for ranking the performance of alternative plan formulations that can be correlated and incorporated to Sandy Recovery planning objectives and stakeholder values. A challenge to the Corps is justifying NNBF solely based on their potential to reduce damage from extreme storms. An alternative approach, presently being reviewed, is to evaluate both the Coastal Storm Damage Reduction benefits as well as the long-term resilience of integrated solutions in the alternative analysis. Metrics are being developed to guide planning decisions by providing information to decision makers on a set of possible future conditions and will be discussed in the context of regional resilience and an integrated, systems approach to coastal sustainability.

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REFERENCE CONCEPTS IN ECOSYSTEM RESTORATION AND ENVIRONMENTAL BENEFITS ANALYSIS (EBA): PRINCIPLES AND PRACTICES

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The use of type-specific reference conditions can significantly improve planning, implementation, and monitoring of ecosystem restoration projects. Effective forecasting of restoration effects on aquatic ecosystems, requires an understanding of the structure and function of the system; natural reference systems within a geographical region contribute significantly to this understanding (Griffin et al. 1994). Historically, the application of reference conditions within the USACE was mainly, for the identification of target functions as an integral part of compensatory mitigation requirements of the Clean Water Act of 1977 (USACE 2011) and some limited application to objective setting and design for ecosystem restoration. In recent years, the importance of reference conditions to a suite of applications has been acknowledged by the scientific community (Miller et al. 2011). For instance, establishment of reference sites is paramount to assessment of wetland functions using the hydrogeomorphic function assessment (Smith et. al. 1995).

However, despite the myriad of guidance related to stream and wetland functions assessment, appropriate criteria in regards to identification of reference conditions and reference approaches have not been adequately developed across all aquatic ecosystem types. Moreover, reference conditions concepts have not thus far been utilized as a basis for quantifying environmental benefits despite several potential advantages relative to other options. The objectives of this presentation are three-fold: 1) to prescribe uses of reference conditions as a basis for identifying metrics and assessing restoration benefits; 2) to introduce a systemized process to facilitate the selection of suitable reference approaches; and 3) to propose the development of reference condition index (RCI) that could serve to guide the application of reference concepts to environmental benefits assessment.

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POST SANDY BRADLEY BEACH MARITIME FOREST CREATION: A SMALL SCALE RESILIENCY PROJECT WITH LARGE SCALE APPLICATION

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Coastal lakes are unique features and an important natural resource of New Jersey's coastline communities in Monmouth and Ocean counties but the ecological health of these seaside lakes is threatened by heavy residential development that has greatly impacted the ecology, biodiversity, and water quality of these lakes. At the same time, increased storm intensities, as demonstrated by Hurricane Sandy, have shown the vulnerability of these lakes and the adjacent ocean beach front communities. A comprehensive effort to restore these coastal lakes and beaches is required for the continued sustainability and improved resiliency of those New Jersey shore communities and their coastal lake environs. The Bradley Beach Maritime Forest Creation/Restoration Project was implemented as a small-scale case study that could serve as model and template for future, more comprehensive resiliency restoration efforts.

The project site was located in a former municipal hard-pan lot lying between the Fletcher Lake shoreline and the beach front boardwalk of Bradley Beach, New Jersey. The restoration of the site was achieved through removal of pavement and debris, the creation of graded sand dunes and ridges, and intensive planting with native seashore trees, shrubs and herbaceous plant species. The planting and elevated grades were set to create a back-dune ecosystem that will enhance the ecology of the site and improve the resiliency of the shoreline. In addition, a path was designed leading from the lakeside drive through the maritime forest to provide access to the town's boardwalk and beach.

Although relatively small in scale, the project could be replicated in more seashore communities along the New Jersey coast and potentially at a much greater scale along the eastern seaboard. The Bradley Beach Maritime Forest Project is not only a successful model for project design and construction but it also demonstrated how community consensus can be grown and funding allocated. The project work was realized through a combination of strong municipal support, private sector resources, small grants, and a considerable amount of volunteer work and in-kind service. In the current economic environment and with sometimes limited funding, this restoration effort highlights alternative paths for completing important restoration efforts.

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PUBLIC INVOLVEMENT IN PONTCHARTRAIN RESTORATION

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The Mississippi River Gulf Outlet (MRGO) drastically altered the coastal landscape and ecology of the Pontchartrain Basin, culminating in catastrophic storm surge and flood damage during Hurricane Katrina. Comprehensive, sustainable restoration of the ecosystem is an important part of resiliency for the Greater New Orleans region. Through coalition-building and strategic partnerships, stakeholder groups have raised the profile MRGO ecosystem restoration needs and impacted federal and state planning processes to better reflect independent science and community concerns.

The MRGO Must Go Coalition is a group of 17 national, state and local environmental and community organizations working to see the MRGO ecosystem restored. Since 2006, the Coalition has championed innovative community outreach and education strategies, a productive working relationship with government agencies, and continuous outreach and advocacy to local, state, and federal officials to help further the cause. The Coalition's diverse partnerships with coastal scientists, large landowners, and community leaders shaped technical recommendations for restoration and earned widespread support including the State of Louisiana and the local levee board as well as dozens of NGOs, and tens of thousands of individuals across the nation. The MRGO and its high profile in Hurricane Katrina destruction and recovery has served as an opportunity to educate and engage local government officials and state legislators on coastal restoration.

Today, the Coalition continues to build on its past success as the broader coastal restoration issue evolves to encompass more diverse funding sources, new plans, and new players. The discussion will include restoration advocacy successes, obstacles, and lessons learned, as well as a look to what is on the horizon for MRGO ecosystem restoration.

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PLENTY OF EELS: INDUSTRIAL ACTIVITY, ENVIRONMENTAL QUALITY AND ECOLOGICAL RESTORATION IN THE PARRAMATTA RIVER, AUSTRALIA

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The Parramatta River is a highly convoluted estuarine system flowing eastward into Port Jackson (Sydney Harbor) within the greater catchment of Sydney, Australia. Parramatta is derived from a local Aboriginal word meaning 'plenty of eels' but over the past 200 years, the waters and sediments of the river have been steadily impacted by a diverse range of industrial activities including tanning, coal gasification, petroleum refining, paint and pesticide manufacturing and metal working. Many of these industries have since moved elsewhere, making way for residential development within the urban sprawl of Australia's largest city. There is a strong desire from local councils and both state and federal environmental agencies to cleanup the river and restore lost habitats that historically characterised the river.

At present, however, the Parramatta River has retained the dubious honor of the most heavily polluted river in New South Wales. It is considered one of the five most polluted rivers in Australia. River sediments are contaminated with a wide range of metals and organic chemicals. Historically, industrial development impacted more heavily along the southern side of the river due to access constraints to the northern bank. The contamination status of sediments in different bays along the river is directly related to the type of industrial activity historically undertaken within each sub-catchment. Water quality is also degraded within the river, causing some local governments to issue advisory notices to avoid primary and secondary contact, especially after rain events. Advisory fish and shellfish consumption bans are also in place for the entire estuarine section of the Parramatta River due to high levels of dioxins and other organic contaminants, some of which are believed to have been mobilised during early sediment remediation activities within the river.

Local pressures favoring restoration of the river are growing, and a new generation of environmentally savvy residents is campaigning for remediation of former industrial sites and the restoration of ecological communities along the shores of the river. Several ecological challenges also must be addressed in addition to the removal of contamination. Climate change has a large influence on watersheds along the eastern Australian coast. This has induced unpredictable shifts in water quantity, vegetation, species composition, food chains and the ability to discern the characteristics of stable habitat in the Parramatta River. This has made restoration work difficult to plan and implement in the river, and elsewhere in eastern Australia. This presentation provides an overview of key threatening processes and management issues associated with public and government visions for restoration of the Parramatta River. The discussion is illustrated with examples of recent and current remediation and restoration projects that highlight a range of successful and not so successful, approaches.

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FOREST HEALTH BASED SCENARIO BUILDING AS AN ACCESSIBLE TOOL FOR CLIMATE CHANGE MANAGEMENT IN BRUCE PENINSULA NATIONAL PARK

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The global climate is changing; there are many predictions about the ecological impacts, and even more uncertainty. Predicted ecological impacts include northward shifting biomes, invasive species, decoupling of biotic interactions, all of which are threats to the ecological integrity (EI) of Canada's National Parks System. To maintain EI, parks must be managed for resilience with climate change in mind. Lack of human and financial resources are restrictions to managing for climate change, challenges exacerbated by government cutbacks in 2012. To overcome these restrictions a tool for informing management in a climate was designed using an existing research program and management based scenario building at the case study location of Bruce Peninsula National Park (BPNP). The tool designed for informing management is called Scenario Building, which accounts for uncertainty and focuses on the essential drivers of the local ecological community. Diversity and health in the forest community are essential drivers in the BPNP ecosystem with interactions at many tropic levels so the forest health research program was selected as the basis for scenarios. Results show a range of tree species that require a variety of soil and moisture regimes. Understanding the ecology of the keystone forest species allows for understanding of how they may reacted to predicted climate changes. Regional climate predictions based on the A2 and B1 primary climate scenarios of the IPCC were integrated with the forest health data, and two levels management option- passive and active to develop 4 scenarios that can inform management of the park. Passive and active management were defined by the number of dollars spent on active management. The 4 scenarios developed were: Scenario 1 B1 Passive Management - Status Quo, Scenario 2 B1 Active Management - Regional Resilience, Scenario 3 A2 Passive Management - Evolving Forests, Scenario 4 A2 Active Management- Anticipatory Restoration. A set of scenarios allows managers to set a management trajectory balances resilience and EI with economic viability in the face of climate change. Analysis of the BPNP scenario suite tell us that BPNP is one park that is in a good position to be able to adapt to a changing climate without major risk to EI, however significant steps can be taken to minimize losses or even improve EI by anticipating needs and investing in active management.

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ADAPTIVELY RESTORING AND MANAGING URBAN RIPARIAN AREAS FOR ECOLOGICAL IMPROVEMENT, RESILIENCY AND INTEGRATION WITH LONG-TERM PLANNING INITIATIVES

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Our urban waterfront communities, particularly older east coast cities have been undergoing regional and local planning efforts to revitalize their infrastructure, provide re-development opportunities and stimulate economic rebirth. As plans for revitalization are developed and implemented there is a significant opportunity to integrate ecological restoration and management elements for degraded environmental conditions and natural resources. The urban legacy of development industry and commerce and the associated impacts of channelization, bulkheads/seawalls, dredging, shipping, stormwater run-off and CSOs have significantly impacted aquatic habitats, wetland systems and riparian corridor and floodplain communities. Ecological improvement opportunities include identifying resources conservation and protection needs assessment, environmental impacts evaluation, and ecological restoration needs identification. These opportunities can enhance and restore riparian habitats, provide ecological uplift and regenerate functions that provide valuable ecosystem services for related natural and human communities. There are associated challenges of developing integrated ecological restoration efforts in these urban areas including the amount of fixed infrastructure, the evolution of altered novel ecosystems and the realities of climate change including sea level rise. This presentation will explore several examples and case studies from urban areas including Philadelphia, PA and Baltimore, MD. These examples will depict integrated efforts and projects that provide living shoreline functions, aquatic and wetland habitat restoration, enhancement of riparian and greenway corridors and stormwater green infrastructure elements. These elements are focused on enhancing habitat functions, improving water quality, increasing biodiversity and providing associated recreational, educational and stewardship opportunities along our waterfronts. Approaches to achieving these goals will be discussed, as will thoughts on future needs and opportunities to explore for the next generation of urban restoration efforts.

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THE SOUTH ATLANTIC CONSERVATION BLUEPRINT 1.0: A LARGE-SCALE COLLABORATIVE RESPONSE TO CHANGE

Rua S. Mordecai and ***Hilary Morris***
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There are twenty-two Landscape Conservation Cooperatives (LCCs) across the United States that also reach into Canada and Mexico. This network of cooperatives were set up to define, design, and deliver landscapes capable of sustaining natural and cultural resources in the face of such threats and stressors as climate change, population growth, and urbanization.

The South Atlantic LCC region, which includes more than 89 million acres of land and water from Southeast Virginia to Northern Florida, typifies the rapid natural and cultural change happening in the American South. A broad community of individuals and organizations are working together within the South Atlantic LCC to spatially depict the places and actions needed to sustain the region's natural environment and cultural heritage in the face of this rapid change. We will present a first version of this "Conservation Blueprint" and demonstrate how the Blueprint deals with future changes like urban growth, climate change, sea-level rise, and future water demand at tangible management scales.

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INNOVATIVE APPROACHES, METHODS AND TECHNIQUES FOR IMPROVING WATER QUALITY

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Pinellas County is the most densely populated county in Florida and is 97% built out which creates large amounts of non-pervious surfaces that result in massive amounts of stormwater runoff. Because of the high population, built out environment, and amount of runoff, 85% of the waters are impaired. With the high percentage of impaired waters and the potential of large fines from the EPA, the County was determined to improve water quality and save money.

The County instituted a fertilizer ordinance in January 2010 to reduce the amount of pollutants reaching Tampa Bay with a two-pronged approach. The first was to reduce chemicals and the second was to mandate education leading to certification. The ordinance banned nitrogen and phosphorus fertilizer application in the summer; and mandated educating landscape maintenance personnel as to the proper ways to handle green waste.

As part of the educational process all landscape professionals were required to demonstrated proficiency by passing the test (score >75%) in order to receive their certificate and decal. UF/IFAS Extension serves as the County's educational provider and contributed to the development of the course. Some of the topics covered include: lawn and landscape cultural practices; turf management; and debris management.

Program implementation challenges included time constraints, client learning needs, money, staff resources and technology. Approaches used to address challenges included using technology such as TurningPoint to ensure that participant grades were available at the end of class and matched with participants. This process allowed staff to provide feedback to participants regarding test retakes, and provision of certificates and decals.

Ninety classes taught 3,074 people between Oct 2010 and Sept. 2013 with an average knowledge increase of 37%. The passing rate was 98%. The increase in knowledge these landscape maintenance personnel have achieved should translate into management of green waste so it does not reach the storm drainage system and does not bring pollutants to Tampa Bay and other water bodies. Also, having learned basic plant best management practices these landscapers will produce healthier plants which are better at taking up nutrients and usually have less pest problems requiring less pesticides.

In conclusion, development of training for landscape personnel that have a large impact on the way green waste is managed is an innovative approach to reducing water pollution in a county whose landmass is heavily impervious. The methods and technologies used to do this training are widely available and were used to reach the required goal of immediate grades.

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S. Mugerwa
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Rangeland degradation attributed to overgrazing, inappropriate fire regimes and indiscriminate tree clearing among other factors is a major constrain undermining the productivity of extensive grazing production systems in the drylands of Uganda. As such, the basal vegetation in most of Uganda's rangelands is characterized by dots of sparse herbaceous layers interspaced with extensive bare surfaces. The study sought to restore pasture vegetation on the extensive bare surfaces in an attempt to avail adequate forage resources to livestock as well as to improve the livelihoods of millions of Ugandans dependent on extensive grazing production systems for survival.

The contribution of various pasture restoration techniques in enhancing pasture productivity on degraded bare surfaces was examined. Six treatments were studied- 1. Resting bare surfaces from animal activity (R), 2. Resting bare surfaces from animal activity coupled with reseeding the surfaces with appropriate pasture species (RR), 3. Night kraaling herds of cattle on bare surfaces coupled with resting the surfaces from animal activity (NR), 4. Night kraaling herds of cattle on bare surfaces, reseeding of kraaled surfaces with appropriate pasture species and resting the surfaces from animal activity (NRR), and 5. Control (no reseeding, night kraaling and resting). The treatments were randomly allocated to 20 experimental plots of 50 x 20 meters each following a Randomized Block Design with four replications. Data on soil nutrient status and pasture productivity was collected covering three dry and three wet seasons.

The soil physical-chemical properties were significantly ($p<0.05$) improved by treatments involving night kraaling. The mean soil pH in treatments involving night kraaling (NR and NRR) improved from 3.5 to 6 while the mean soil pH for other restoration treatments (R, RR and C) declined from 4.1 to 3.7. Also, amendment of experimental plots with cattle manure through night kraaling improved soil organic matter (OM) by 63% from 1.2 to 3.3%. Soil nitrogen (N) was also improved by 72% from 0.06 to 0.22%. The pasture dry matter yield varied significantly ($p < 0.05$) with the various pasture restoration treatments and highest mean dry matter yield (3450kg/ha) occurred in plots subjected to NR, followed by 3210 kg/ha obtained from NRR-treatment plots. Lowest mean dry matter yield was obtained from C (0 kg/ha) and R (1380 kg/ha) treatment plots. Due to introduction of leguminous pasture species through reseeding, the crude protein content (CP) of pasture samples obtained from NRR treatment plots was highest and was above 7%, the minimum CP required for efficient functioning of the rumen environment. The proportion of bare ground was significantly reduced by the various restoration treatments. During the period of the study, the mean proportion of bare ground was 7, 12, 50.4, 71 and 100% in plots subjected to NRR, NR, RR, RO and C respectively. We conclude that resting night kraaled bare surfaces from animal activity coupled with reseeding is an effective pasture restoration technique that significantly improves soil properties, pasture production, nutritive quality and reduces the proportional of bare surfaces on degraded bare surfaces.

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AQUATIC MITIGATION FOR THE MODIFIED CENTRAL CITY PROJECT: RIVERSIDE OXBOW AND SYCAMORE CREEK RESTORATION

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The presentation will describe the planning and design process to restore a remnant oxbow and former creek channel along the West Fork of the Trinity River (river) in Fort Worth, Texas. The main challenge in this project was balancing the goals of restoration and aquatic mitigation with site constraints in urban environment. The presentation will focus on these constraints and the describe extent to which the channel could be naturalized and still maintain a stable streambed and banks while providing habitat function in the form of pools and riffles, appropriate substrates and protective cover.

The Modified Central City Project in Fort Worth includes various sub-projects including Riverside Oxbow (Oxbow) that provides valley storage and aquatic mitigation, coinciding with ecosystem restoration planned by the local sponsor, Tarrant Regional Water District (TRWD). Construction of the proposed Marine Creek low water dam will inundate approximately 1,875 feet of perennial riffle-pool complexes within Marine Creek resulting in a decrease of aquatic habitat. The planned aquatic habitat mitigation for the impacts to Marine Creek includes habitat improvements on Sycamore Creek and a remnant riverside oxbow. Sycamore Creek was previously separated from old oxbow when the West Fork of the Trinity River was channelized and straightened in the 1950's.

The proposed aquatic mitigation actions on Sycamore Creek include the restoration of a previously filled-in reach of the creek as well as enhancement of an abandoned oxbow of the river. Currently, the upstream end of the oxbow is plugged with an earthen dike. By restoring flow through the old oxbow, it is anticipated that the stream will once again take on many of the characteristics of a natural stream channel, more closely reflecting the historical aspect of the historic oxbow prior to the construction of the modified river channel as well as incorporate characteristics of the impacted Marine Creek channel.

The design approach for Sycamore Creek included determining an alignment, channel slope, profile and the appropriate location for riffles, pools, and runs, as well as substrate type. The proposed channel morphology includes alternating riffle/pool/run structural sequence and varying substrate of gravel, cobble, sands, and native material as well as woody debris in the pool and boulders in the riffle sections.

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REGIME CHANGES, RESILIENCE, AND RESTORATION: NO REVERSE GEAR

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Changes in land and water use have increased to a state where the old principles and rules governing restoration ecology may not apply. There is a need to look at the big picture and examine how one can analyse these large scale changes. We have a change in the 'regimes' of space and time on a pace and scale never really witnessed on this planet. This means that restoration to some historical norm - often the subconscious or implied default of academics and practitioners alike - is becoming increasing unlikely. On a grand scale, this means we need to consider what regime changes mean for the very theory and application of restoration ecology - a change to the regime of restoration ecology itself. The 'reverse gear' in restoration ecology probably never existed but now even trying to maintain 'neutral' may be difficult. Work in my research group can assist this decision makers coping with novel ecosystems and the haziness of trying to measure resilience. We will examine the theories of complex systems and how they can assist restoration ecology as this mass scale and rapid transition in regimes is occurring. The objective is to examine the changes to our conceptual and theoretical framework (how we think in restoration ecology), the analytical innovation needed, and how this can be translated into workable governance, policy, and on-the-ground action.

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HABITAT MANAGEMENT AND CREATION TO BALANCE ANTHROPOGENIC REQUIREMENTS AND SPECIES CONSERVATION IN THE UNITED STATES

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The Lower Colorado River Multi-Species Conservation Program (LCR MSCP) is a 50-year partnership of Federal and non-Federal stakeholders, created to respond to the need to balance the use of Lower Colorado River water resources and the conservation of native species and their habitats in compliance with the Endangered Species Act. Twenty-six Federal or state-listed candidate and sensitive species and their associated habitats, ranging from aquatic and wetland habitats to riparian and upland areas, are covered under the LCR MSCP. The program, initiated in 2006, addresses the biological needs of mammals, birds, fish, amphibians, and reptiles, as well as invertebrates and plants. Implementing the LCR MSCP will create at least 8,132 acres of new habitat (5,940 acres of cottonwood-willow, 1,320 acres of honey mesquite, 512 acres of marsh, and 360 acres of backwater) and produce over 660,000 subadult razorback suckers and 620,000 bonytails to augment the existing populations of these fish in the LCR. The program also established a $25 million fund to support projects implemented by land use managers to protect and maintain habitats for covered species which existed at the start of the program. The program's estimated cost in 2003 dollars is $626 million, and is adjusted annually for inflation. Total cost of the program is currently estimated at over $1.4 billion.

The Colorado River is a highly managed and regulated river system which flows over 1,400 miles from the headwaters in Rockies to the Sea of Cortez in Mexico. The lower basin captures water released from the upper basin (approximately 9 maf annually) in Lake Mead and then through a series of dams and reservoirs delivers 7.5 maf to users in the United States and 1.5 maf to Mexico. In the United States, the Colorado River water is used to irrigate thousands of acres of crops, generate hydroelectric power, and provide drinking water to millions of people. The LCR MSCP creates and manages habitat within the United States from Lake Mead to the southerly international boundary with Mexico.

The creation and management of habitat in this highly managed and altered river system is possible, but often does not resemble traditional river restoration. The highly dynamic Colorado River system has been replaced with a controlled, relatively tame river, with little overbank flooding even during high water releases. When historic conditions no longer exist, disturbances must be anthropogenic making habitats created under the LCR MSCP often highly managed, much like the river. Through monitoring and species research while applying adaptive management principles, the program attempts to create land cover types on specific portions of the river corridor and manage these Conservation Areas for the benefit of covered species. To date, species response has been favorable. Habitat creation and management examples are presented to share experiences, successes, and failures to assist others creating and maintaining habitat in a highly managed river corridor.

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LOUISIANA COASTAL RESTORATION: PLANNING, PERMITTING, AND IMPLEMENTING RIVER DIVERSIONS

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Recognizing the importance of implementing comprehensive large scale restoration on the Louisiana coast, National Wildlife Federation joined the Environmental Defense Fund and National Audubon Society to form the Mississippi River Delta Restoration Coalition (MRDRC). MRDRC in turn expanded the coalition to in-state Non-Governmental Organizations (NGOs), including the Coalition to Restore Coastal Louisiana and the Lake Pontchartrain Basin Foundation and maintains financial partnerships with other local and state NGOs, the Nature Conservancy in Louisiana, the Louisiana Wildlife Federation and Restore or Retreat.

While we advocate for the full range of measures required to protect existing coastal wetlands and maintain community resiliency, we concentrate on building consensus for and clearing roadblocks to large scale river diversions, the only hope of countering marine transgression and sea level rise. These river diversions have been a central focus, as opposed to other important restoration measures, such as dredging to build marsh platform or barrier islands, because they are complex, controversial, and unprecedented. They also achieve a central goal of our organizations, which is to utilize and restore natural processes to the maximum extent practicable by restarting the delta building process, and restoring system function.

The Louisiana coastal land-loss crisis began to receive widespread attention over forty years ago and has been the subject of over thirty years of concerted research and planning. At the culmination of each planning cycle, documents and reports were produced which invariable highlighted the need to undertake large scale river diversions. For instance, in 1993, responding to Federal legislation, the Coastal Wetland Planning, Protection and Restoration Act Task Force agencies produced a final Environmental Impact Statement. A discussion of sediment diversions concludes: "It is clear that additional projects are needed, at least some of which must operate *on an unprecedented scale*." (p. 46, CWPPRA EIS, 1993.)

In 2012 all the plans passed a critical threshold when the Department of Justice earmarked $1.275 billion for barrier islands and sediment diversions from the BP and Transocean criminal Clean Water Act settlements, and in 2013 when the state of Louisiana began detailed planning and design for the mid-Barataria Diversion. But despite the fact that large scale diversions have been official Federal policy at least since 1993, agencies are not yet prepared with the critical studies and procedures needed to permit such a diversion.

We are working with agencies to resolve outstanding issues which stand in the way of implementation, in many cases learning about obstacles as the agencies themselves discover them.

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TROPICAL STREAM CHANNEL RELOCATION DESIGN TO ACHIEVE RCRA AND SECTION 404 CLEAN WATER ACT OBJECTIVES

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A small tributary channel that feeds the upper Lonfit River on Guam forms the western boundary of a dump created by the Japanese during their 1940's occupation of the island. As an old dump, Dump is an unlined disposal facility and has few to no control systems to manage landfill gas, leachate, surface water, erosion sedimentation, and vectors. The Dump is a 43.5 acre unlined waste disposal facility owned and operated by the Government of Guam. The dump generated leachate streams and contaminated surface and surficial groundwater, which flowed to the Lonfit River, a tributary to Pago Bay. In 1986 EPA issued an administrative order to Guam's Department of Public Works and requested data on discharges in 1997. A Consent Decree was issued in 2004 and a Receiver was appointed. In 2010 a Request for Proposals was issued to remediate the site and work began in 2011 on development of a remediation plan and closure design.

A closure plan was developed and resulted in partial filling of the western channel, a tributary of the Lonfit River. The amount of fill was significant and the design was re-evaluated to reduce wetland and channel loss. To ensure a Resource Conservation and Recovery Act (RCRA) closure design that met the Consent Order requirements, due to site constraints including the limited extent of the property, the closure design could not completely avoid the channel. The closure plan had to be refined and a final closure design footprint was defined. The proposed closure design includes by absolute necessity the realignment of approximately 510 linear feet (lf) of the western channel where existing waste limits, an elevated potential for unexploded ordnance (UXO) and the steep Dump topography represent significant constraints. The surficial deposits in the Dump site vicinity are composed of a few feet of soil and subsoil beneath which the parent volcanic rock is weathered to a depth of 10 to 30 ft., forming saprolite material. Soils beneath and along the Dump perimeter were generally described as being elastic silts derived from highly weathered bedrock featuring high plasticity.

The stream channel dictated by the site constraints and final closure plan results in a 510 linear ft. channel bed segment encompassing 3,570 sq. ft. of forested wetland habitat being filled. The very limited land available on the western portion of the site restricted the ability to fully restore the length of channel; however, a design that mimicked the natural channel features was feasible with a 455 linear ft. channel segment design. The forested wetlands surrounding the stream channel on the western side of the dump is 7.5 ac in area and dominated by Pago and *Palma brava*; most of which will experience no direct impacts. The channel design minimized adjacent wetland impacts and was designed for stability during large storm events, mainly during the rainy season. In addition to the channel bed relocation, approximately 0.5 ac. of forested wetlands habitat will be temporarily cleared and replanted with native forested wetland vegetation. Invasive species will be removed from the surrounding wetlands as well. The channel relocation was designed to achieve a natural channel configuration as similar to the original alignment as possible. The relocated channel will include riffle and pool complexes along its length and a replanting scheme incorporating native species.

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BIODIVERSITY RESTORATION IN INTENSIVE RICE FIELDS IN JAPAN

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Rice fields have been playing an important role as wetland habitat for plants, water birds, frogs, fishes and aquatic invertebrates. More than 5,000 species have been recorded in and around paddy fields in Japan. Traditional rice fields were subdivided into small plots and had relatively large levee areas. Small irrigation ponds were dug in some areas where precipitation was low. Levees provided semi-natural strips of grassland, while ponds were home to many aquatic animals and plants. But these traditional paddies required significant labor, and it is hard to find paddy fields today without improvements that increase paddy size to allow large tractors, rice planting machines, combine harvesters, and engineered subsurface drainage control systems in each field. Coincident with paddy-plot expansion, the number of irrigation ponds decreased from 300,000 in 1950s to 210,000 in 1997 (Morita and Arai 2003). Biodiversity in rice fields has decreased due to both modernization and abandonment of rice fields.

Technology for restoring habitats includes restoring connectivity between rivers and paddy fields, making variations and providing refuge in irrigation canals, restoring semi-natural habitats such as vegetation on levees. Various types of habitat devices, such as fishways and fish-nest blocks, have been installed in many drainage canals. Also, fundamental information about the distribution and habitat properties of fish has been gradually accumulated for rural areas of Japan. The number of local communities and groups that take part in the Survey on Lives in rice fields and Surrounding Environment increased from 118 in 2001 to 616 in 2009.

Food safety and low environmental impact are priority themes as well as activation of village communities. Establishing a biodiversity certification or labeling is an approach to promote to safety- and biodiversity-conscious farming through charismatic and culturally iconic species. These species include birds, fish, plants, and aquatic insects, all commonly vulnerable to modernized farming. Enhancement of the cooperation between farmers and consumers has been responsible for success of these programs, including the adoption of temporary ownership in some cases. For example, a temporary owner may pay 30,000 for a paddy (100 m^2) . The temporary owner is invited to work on the farm, observe nature, and get at least 30 kg of rice harvested from the paddy. The importance of social capital in rural communities is being recognized in these efforts.

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EFFECTS OF ORGANIC FERTILIZER (COW DUNG) AMENDMENT ON PHYTOREMEDIATION OF COPPER AND IRON-CONTAMINATED AQUATIC ENVIRONMENT BY WATER HYACINTH (*EICHHORNIA CRASSIPES* [MART.] SOLMS)

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This study was carried out to investigate the ability of water hyacinth (*Eichhornia crassipes)* to absorb and translocate iron (Fe) and copper (Cu) in the presence of cow dung (biostimulant). The objectives of this study were (i) to determine the potential of water hyacinth (an invasive species) in absorbing copper and iron from aquatic ecosystems and thus, restore the ecosystem to its initial status; (ii) to determine the effects of organic fertilizer amendment on the uptake of iron and copper from aquatic environment.

The study was conducted with three concentrations of Fe and Cu; 10mg/L, 15mg/L, 20mg/L and control (0mg/L) and were separately amended at two concentrations (0.5mg/L and 1.0mg/L) of organic fertilizer (cow dung). The experiment was conducted in triplicates and it lasted for 12 weeks. Statistical analysis showed that there were significant differences among treatments ($p<0.05$). The results showed that iron (Fe) was highest in the root (1.12±0.42mg/L), while copper (Cu) was highest in the leaf (0.38±0.06mg/L) and both occurred at 20mg Fe(Cu)/Litre of water. Translocation Factors (TF) for Fe ranged from 0.49±0.57 - 0.68±0.27 in leaf, and 0.64±0.17 - 0.77±0.18 in the stem. While the TF for Cu ranged from 0.78±0.08 - 1.12±0.12 in leaf and 0.72±0.32 - 1.09±0.19 in the stem. This reveals that Cu had better translocation capabilities than Fe. The highest bioconcentration factor (BCF) for Fe and Cu were 2.32±0.65 at 20mg/L and 0.72±0.01 at 15mg/L obtained in the root and leaf respectively, indicating that the accumulation potential of Fe by water hyacinth is higher than Cu. The effects of biostimulation by organic fertilizer (Cow dung) on metal uptake show that Fe and Cu were most absorbed (1.20±0.23mg/L for Fe; 0.04±0.05mg/L for Cu) in the root in the treatment amended at 1.0mg Cow dung/Litre of water and lowest in the control (0.04±0.05mg/L for Fe; 0.03±0.01 for Cu). Thus, nutrient amendment increased the uptake of Fe and Cu by water hyacinth.

According to the accumulation capabilities of the investigated plant (*Eichhornia crassipes)*, this study showed that the plant is a promising candidate for phytoremediation and bio-monitoring programmes for contaminated water especially those polluted by metals like Fe and Cu. Therefore, water hyacinth can be helpful in the restoration of metal-polluted aquatic ecosystems.

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REAL-TIME MONITORING AND REPORTING OF THE LEADING EDGE OF AQUATIC INVASIONS: THE USGS NAS ALERT SYSTEM

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The Nonindigenous Aquatic Species (NAS) database (http://nas.er.usgs.gov) functions as a repository and clearinghouse for occurrence information on nonindigenous aquatic species from across the United States. It contains locality information on more than 1,100 species of vertebrates, invertebrates, and vascular plants introduced since 1850 (Fuller et al. 1999). Taxa include foreign species as well as those native to North America that have been transported outside of their natural range. The NAS web site provides immediate access to new occurrence records through a real-time interface with the NAS database. Fact sheets, distribution maps, and information on new occurrences are continually posted and updated. Dynamically generated species distribution maps show spatial accuracy of the locations reported, population status, and provide links to the full specimen record.

Awareness of, and timely response to, novel species introductions by those involved in nonindigenous aquatic species management and research requires a framework for rapid dissemination of occurrence data as it is incorporated into the NAS database. In May 2004, the NAS program developed an alert system to notify registered users of new introductions as part of a national early detection/rapid response system. Here we summarize information on system users and dispatched alerts from the system's inception through the end of 2013. The NAS alert system has registered over 1,800 users throughout its lifetime, with ~860 current subscribers. A total of 1,412 alerts have been transmitted up through 2013. More alerts were sent for Florida (161 alerts) than for any other state. Fishes comprise the largest taxonomic group of alerts (540), with mollusks, plants, crustaceans, and amphibians/reptiles each containing over 100 alerts. Most alerts were for organisms that were intentionally released (467 alerts), with shipping, escape from captivity, and hitchhiking also representing major vectors. To explore the archive of sent alerts and to register, the search and sign-up page for the alert system can be found at http://nas.er.usgs.gov/AlertSystem/default.aspx.

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OPERATIONALIZING RESILIENCE FOR ECOLOGICAL RESTORATION

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Although managers are increasingly focusing on ecological resilience as a goal for ecosystem restoration, its efficacy as a restoration target remains unclear. Resilience could be an important innovation for restoration practice, because it allows for flexibility to meet a variety of needs, allows for the dynamic nature of ecosystems, and allows for managing in accordance with historic conditions without requiring them as endpoints. Resilience, however, is also difficult to define and measure and its use in management planning is often overly vague. Unless resilience can be effectively operationalized for restoration, its use as a restoration target may result in the abandonment of important ecological legacies in favor of expedience and convenience. In this presentation, I discuss the evolution of the concept of ecological resilience as a restoration target and discuss pitfalls for managers to avoid when using resilience in restoration plans.

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STATE IMPLEMENTATION OF REGIONAL SEDIMENT MANAGEMENT – ECONOMIC, ENVIRONMENTAL AND COLLABORATIVE SUCCESS STORIES FROM TEXAS AND MISSISSIPPI

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The South Padre Island Beach Nourishment Project (SPI Project) and the Mississippi Beneficial Use of Dredged Material Program (MSBU) are shining examples of successful cooperative efforts between multiple partners to address chronic coastal habitat loss by using a valuable resource formerly referred to as "spoil". State and local entities get sand at a much lower cost than traditional methods. The Corps benefits through the use of dredged material as a resource instead of placing the material offshore and out of the littoral system.

The SPI Project is a joint effort between the City of South Padre Island, the Texas General Land Office (GLO), Cameron County, and the U.S. Army Corps of Engineers (Corps) located on a combined 4,000 feet of Gulf beachfront at Padre Island adjacent to the Brazos-Santiago Pass jetties. The project uses sand dredged by the Corps during maintenance of the Brownsville Ship Channel and has been conducted nine times since 1997 under a memorandum of agreement with the Corps. The GLO uses coastal erosion funding with City of SPI and County funds to pay the incremental cost required by the Corps to get the sand to the beach. The SPI Project provides State and local with sand at a much lower cost and the Corps benefits by retaining the material as a resource in the littoral system. The sand placed on the beaches of SPI not only helps to hold the line against coastal erosion, but also enhances habitat for endangered sea turtles and piping plovers. Economic analysis of the SPI BUDM project indicates that the project provides a benefit cost ratio of 9:1 for SPI.

The MSBU was reassembled "post Katrina" and has been supported a growing Beneficial Use Group (BUG). The public/ private BUG promotes a creative process to align ecological priorities with dredged resources and has spurred development of new legislation, policies and techniques. The MSBU has recently produced Mississippi's first non-federally sponsored BU projects. In 2012, Mississippi State Port Authority at Gulfport (MSPA) implemented an expansion that produced 330,000 cubic yards (CY) which facilitated 90ac. of marsh restoration at Deer Island. In 2013, V.T.Halter Marine (Halter) and the Port of Pascagoula began a 70 acre habitat restoration project on the north shoal of Round Island using 350,000 cy from a dockside expansion. Mississippi will require larger projects in the future. The state has lost 10,000 ac. of marsh since the 1950s and has associated declines in fisheries production that can be readily offset if private and federal dredged materials are fully directed toward restoration. A key factor is the development of pre-permitted BU projects which can accommodate dredged materials from various sources over years instead of building projects for each material source.

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EFFECTS OF STORMWATER MANAGEMENT AND STREAM ENGINEERING ON WATERSHED NITROGEN RETENTION

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Restoring urban infrastructure and managing the N cycle represent major challenges for urban ecosystems. We investigated whether stormwater control measures (SCMs) integrated into restored and degraded urban stream networks can influence watershed N loads. We tested this hypothesis by comparing N retention metrics in 2 urban stream networks (1 restored and 1 urban degraded) with SCMs and a forested reference watershed at the Baltimore Long-Term Ecological Research (LTER) site. We hypothesized that hydrologically connected floodplains and SCMs are "hot spots" for N removal through denitrification because they have ample organic carbon, low dissolved oxygen levels, and high residence time. We tested this hypothesis by comparing N retention metrics in 2 urban stream networks (1 restored and 1 urban degraded) with SCMs and a forested reference watershed at the Baltimore Long-Term Ecological Research (LTER) site. At all 3 sites, we used a combination of: (1) reach-scale mass balances of N and carbon conducted monthly for 2 years during baseflow and storms (n=250), (2) in-stream tracer injection studies to measure seasonal nitrate uptake and groundwater inputs (n=6), and (3) ^{15}N *in situ* push-pull tracer experiments to measure seasonal N removal via denitrification in SCMs and floodplain features (n=72). The SCMs consisted of inline wetlands installed below a storm drain outfall at one urban site (restored Spring Branch) and a wetland and wet pond configured in an oxbow design to receive water during high flow events at another highly urbanized site (Gwynns Run). The SCMs significantly decreased total dissolved N (TDN) concentrations at both sites and significantly increased DOC at Gwynns Run. There was variable DOC retention and export within the stream network. At Spring Branch, TDN retention calculated by mass balance was significantly higher in stream reaches with hydrologically connected floodplains, 2.01 ± 0.77 kg/day (mean ± SE), than in SCMs, 0.053 ± 0.025 kg/day ($p < 0.05$). At Gwynns Run, mean TDN flux calculated by mass balance was 3 orders of magnitude higher in the stream reaches, 2.00 ± 1.6 kg/day, than in SCMs, 0.005 ± 0.597 kg/day. Mean ^{15}N *in situ* denitrification rates were high in both SCMs and hydrologically connected floodplains of the streams. Hydrologically connected floodplains can be important "hot spots" for N retention and removal at a watershed and stream network scale because these areas likely receive perennial flow through the groundwater-surface water interface during both baseflow and storm events, while SCMs only receive intermittent flow associated with storm events. Our results show that coupling of hydrologic fluxes with biological N retention processes is necessary to accurately evaluate the importance of engineered features on controlling N retention at the watershed scale. Stream N export depends not only on per-area retention rates but also on the area and duration of exposure in each feature.

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MODELS TO PREDICT THE EFFECTS OF COASTAL RESTORATION IN LOUISIANA ON FISH AND WILDLIFE

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We compared the effects of management and environmental uncertainty on habitat quality for selected fish and wildlife in coastal Louisiana with one model for neotropical migrant songbirds and 12 models for individual species of fish and wildlife. Stakeholders decided which animals to target; many are migratory or transients, and many are commercially important.

Without management, habitat quality for neotropical passerines and seven target species is predicted to decline in 50 years to 63% of that currently available when averaged across these models (ranging from 51% to 78% depending on environmental uncertainty). These animals include all of the birds that we modeled plus crawfish, American alligators, and muskrats. All animals were in common partly depend on *Spartina patens*-dominated wetlands, or lower salinity emergent wetlands, for highest quality habitat. Management is predicted to slow declines in habitat quality to 79% of that currently available when averaged across these models (ranging from 70% to 89% depending on environmental uncertainty).

Without management, habitat quality for five target species is predicted to increase in 50 years to 118% of that currently available when averaged across these species (ranging from 108% to 133% depending on environmental uncertainty). All species, except the largemouth bass, partly depend upon water saline enough to allow *Spartina alterniflora* to dominate emergent wetlands. Management is predicted to slow increases in habitat quality to 108% of that currently available when averaged across these species (ranging from 101% to 121% depending on environmental uncertainty).

All of the target species whose habitat is predicted to decline belong to the public; i.e. to people of the state of Louisiana in the case of resident animals, to people living in countries bordering the Gulf of Mexico in the case of the estuarine-dependent fish, and to the people of the Americas in the case of the migratory birds. While some are only indirectly important economically, the monetary costs are likely significant given that Louisiana's coastal wetlands represent 39% of coastal salt marshes and 44% of coastal freshwater marshes in the conterminous United States. Thus, declining habitat quality in Louisiana probably will cause market and non-market losses, which although concentrated in Louisiana, will extend across the Americas.

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GERMINATION OF TROPICAL TREE SPECIES IN HEAVY PETROLEUM CONTAMINATION: A PROMISSORY RESTORATION WAY

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Four species of trees were selected to evaluate the tolerance to heavy crude oil contamination by means of a tolerance index integrating germination, height, biomass and survival as variables. Fresh seeds to *Cedrela odorata* (tropical cedar), *Haematoxylum campechianum* (tinto bush), *Swietenia macrophylla* (mahogany), and *Tabebuia rosea* (macuilis) were planted in a Vertisol to which heavy crude petroleum was added at four different treatments (C0: 0, C1: 18 940, C2: 44 000 and C3: 57 000 mg kg-1), with the control being uncontaminated soil. The experiment was carried out in a greenhouse during 203 days with a completely random design.

The presence of petroleum in soil stimulated and increased germination of *S. macrophylla* and *C. odorata*, accelerated the germination of *T. rosea*, and did not affect the germination of *H. campechianum*. The height and biomass of all species was reduced in the presence of petroleum in the soil. The survival of *S. macrophylla* and *H. campechianum* was not affected by petroleum at any concentration studied. On the other hand, *C. odorata* and *T. rosea* showed high mortality at all concentrations. The tolerance index showed that *S. macrophylla* was best at tolerating petroleum in soil and could be employed as a productive alternative for the advantageous use of contaminated sites.

The use of tree species could be important because of the great potential of trees for phytoremediation due to their long life, biomass and deep roots that can penetrate and remediate deeper soil layers.

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LID REVEALED IN WASHINGTON, D.C.: TRUE DATA FROM THE TRENCHES

A. Oetman
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This discussion will incorporate four years of low impact development (LID) installation data with a local, project-by-project perspective. It will dive into how different methods of outreach/program management have yielded different volumes and concentrations of LID installations. These installations will ultimately be presented in gallons of stormwater detained/retained in Washington, D.C.

Since 2009, we have installed several thousand stormwater mitigation features. Some of these features include rain gardens, native plant landscaping, rain barrels, cisterns, shade trees, vegetated roofing, pervious paving and much more. These features emulate a more natural hydrologic system and slow down, capture, cool, and scrub pollutants from our rain water. This helps us to mitigate harsh conditions of Washington, DC's dense urban landscape. Each gallon of rain water or stormwater that mitigated is one less unit of impact on our local streams and ultimately reduces the impact on the Chesapeake Bay. These installations are a direct result of reaching out to residents, business owners, multi-family property residents and houses of worship to with our RiverSmart Homes program. The RiverSmart Homes program uses word of mouth, limited mailings, community events and our website to advertise our program. This method of outreach has driven significant interest from the public. Currently interested participants seem to be coming from specific socioeconomic and geographic demographics. While this method of outreach has driven a strong, consistent interest in participation, it tends to focus our installations in certain areas of the district.

In 2010, a similar LID project, RiverSmart Washington was launched. RiverSmart Washington is a program that incorporates each practice offered under our standard RiverSmart Homes program but at a higher concentration of installations in a small geographic area. This required some different outreach techniques and overall strategy. One way we were able to increase the number of installations within the RiverSmart Washington project, was by increasing the funding from an average of $1500.00 of funding per home to $5000.00 per home. Using this different strategy we can quantify the number of gallons retained within the RiverSmart Washington sites.

This session will explore methods of outreach and program packaging/branding that could potentially increase participation where socioeconomic and/or geographic aspects play into the lack of installations. We can then, based on our existing data, spatially indicate/identify some of the most desirable opportunities for low impact development and show the achievable reduction of stormwater in gallons in Washington DC.

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ECOLOGICAL RESTORATION ON WORKING LANDS: STAKEHOLDER DISCUSSION

***Margaret O'Gorman**, Jeff Popp, and Daniel Goldfarb*
Wildlife Habitat Council, Silver Spring, MD, USA

The purpose this session is to describe the opportunities and challenges for ecological restoration on active industrial and corporate facilities in the United States. The Wildlife Habitat Council is a nonprofit conservation organization that helps companies restore and manage wildlife habitats on their lands. We work with employee-lead teams to develop projects that increase biodiversity, meet sustainability goals and engage local communities. Projects that meet strict, science-based criteria or educational goals are eligible for Wildlife Habitat Council certification. This session will provide participants with the unique opportunity to learn about ecosystem management and restoration on a range of industrial and corporate facilities.

WHC is expanding its signature conservation and education recognition programs to better align with existing conservation initiatives, develop more opportunities for high-quality ecological projects, and encourage our corporate and industrial members to deliver conservation that supports the efforts of our state, federal and non-governmental partners.

Open discussion objectives:
• Share the history and strategic vision of the Wildlife Habitat Council with diverse stakeholders.
• Hear from a broad group of scientists, policy makers, practitioners, and educators about how the Wildlife Habitat Council can strengthen its conservation and education recognition programs.
• Foster new relationships and serve as a catalyst for action and creative partnerships that allows stakeholders to more effectively achieve their own missions.

Topical areas discussions included:
Water
Terrestrial ecosystems
Species in decline
Remediation
Climate change/resiliency
Environmental education and science, technology, engineering and math (STEM)

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ASSESSING THE IMPACT OF CULVERT DESIGN ON THREE ECOSYSTEM FUNCTIONS IN NORTHERN WISCONSIN STREAMS

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Stream restoration projects are often thought to improve ecosystem functions, yet these functions are rarely monitored or evaluated to determine whether projects meet expectations. The USDA Forest Service has worked to improve designs of culverts that are replaced to restore aquatic organism passage with the assumption that ecosystem function will also be better maintained. One such design is the stream simulation culvert, where the streambed and channel through the culvert are rebuilt to mimic natural width, depth and velocity. Our objective was to investigate whether stream simulation designs maintain ecosystem functions better than other replacement designs and compared to non-replaced culverts by evaluating three measures of ecosystem function: hydrologic exchange, CPOM (coarse particulate organic matter) retention, and nutrient cycling. We selected three stream simulation culverts and paired each with a recently replaced, non-stream simulation culvert. Ammonium uptake was measured in reaches (50-400 m long) above and below culverts using standard stream nutrient spiraling techniques. Salt pulses were completed above, through, and below culverts to determine travel times and to model transient storage. CPOM retention rates were determined by releasing leaf analogs and modeling the exponential decay of analogs in transport on reaches above, through and below culverts. CPOM and salt pulses were also completed above and through culverts at nine additional sites (2 stream simulation, 3 non-stream simulation, 4 non-replaced) to determine whether our results were representative of other culverts in the region. All three ecosystem functions were compared using t-tests (nutrient uptake) and two-way ANOVAs with the expectation that reaches would be more similar above, through and below simulation culverts compared to non-stream simulation culverts and non-replaced culverts.

Nutrient uptake velocities ranged from 0.027 to 0.187 mm/sec, with no statistical differences above versus below or between different culvert designs. For average stream velocity (m/sec) both culvert design and the interaction effect between culvert and reach were statistically significant ($p < 0.05$). The mean velocity decreased by 33.8 % from above to through non-stream simulation culverts but increased by 16.7% and 66.1% through non-replaced and stream simulation culverts respectively. The main effects and the interaction effect between reach and culvert design were all significant ($p < 0.05$) for CPOM retention. The mean retention decreased by 63.6% from above to through stream simulation culverts compared to greater decreases of 98.1% and 99.5 % for non-stream simulation and non-replaced culverts respectively. These results suggest that the stream simulation designs have the desired effect of maintaining CPOM retention rates that are more similar to upstream and downstream conditions than other designs. However, none of the three ecosystem function measurements suggest that either replacement culvert designs create lasting differences upstream or downstream of the road crossings.

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ESTABLISHMENT OF *RHANTERIUM EPAPPOSUM* OLIV. COMMUNITY AS FUNDAMENTAL STEP TO MITIGATE CLIMATE CHANGE IN KUWAIT

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The fundamental step to sequester atmospheric carbon remains mass establishment of native plant communities and revegetation of damaged terrestrial ecosystems. Existing terrestrial carbon storage is susceptible to disturbances such as urbanization, excess industrial pollution, and changes in climate and land use. Revegetation of damaged deserts has already been a vital issue not only in Kuwait but also in other gulf countries as the natural ecosystem has been undergoing severe degradation due to several anthropogenic activities. Major impacts due to land degradation include massive loss of vegetation cover and gradual disappearing of key species. Eventually, this will affect the CO2 balance in the atmosphere. Before human-caused CO2 emissions began, the natural processes that make up the global "carbon cycle" maintained a near balance between the uptake of CO2 and its release back to the atmosphere. Although the natural revegetation remains the optimum way of restoring damaged plant communities, it takes time. Re-establishing native vegetation can be very difficult; however by utilizing simple but scientific methods mass production of native plants can be possible.

Arfaj (Rhanterium epapposum Oliv.), an indigenous species to the Arabian deserts is considered to be the most significant plant community suitable for carbon sequestration. It is highly adapted to the local environmental conditions and is fundamental to sustain healthy ecosystems in that region. Thus Arfaj deserves the priority in any restoration projects. Arfaj has high potential to be used in landscaping too. However, difficulties in cultivation maybe encountered, especially as they often have quiet distinct growth conditions, which depends normally on the climatic conditions. Production of arfaj from locally collected seeds is the ideal method, as this will retain the genetic diversity of the location.

The current study reports successful establishment of Rhanterium epapposum community as it might initiate to bring the associated flora and fauna back to its ecosystem. Steps involved in this study are seed collection, seed viability tests, germination methods, acclimatization, field setting, and plant establishment. The results demonstrate that the method is suitable for native plant establishment as well as for revegetation, the fundamental step to sequester CO2 to mitigate climate change.

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AN OVERVIEW OF OYSTER REEF SHORELINE PROJECTS ON THE GULF COAST, AND BEYOND

Tyler R. Ortego
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Estuaries throughout the world are subject to severe environmental challenges. Coastal wetland loss, water quality impairments, ecological damage and fisheries collapse are common problems. Oysters, a common but often threatened inhabitant of estuaries, have been described as "ecosystem engineers" for their ability to modify their habitat. One of the ways that oysters affect their habitat is by protecting shorelines via the hydrodynamic interactions caused by the reef. Via clever configuration of substrate, these reefs can be designed into living engineered breakwaters. By using the reef building nature of the oyster to create breakwaters, structures can be created with less material, lower foundation pressure and fewer construction impacts. In this presentation, we look at a series of case studies using a variety of oyster shoreline techniques. This presentation will look at the similarities and differences between the different techniques, and discuss some of the coastal engineering, as well as ecological aspects of the projects.

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ENHANCEMENTS TO THE NORTHERN GULF COAST FOR COASTAL WATER LEVELS, SURGE MONITORING AND POSITIONING- A GULF WIDE APPROACH TO INCREASING THE NUMBER AND ACCURACY OF GPS BASED REFERENCE STATIONS AND CREATING ENHANCED WATER LEVEL AND WEATHER STATIONS TO SUPPORT COASTAL ECOSYSTEM RESTORATION AND PROTECTION PROGRAMS AND PROJECTS

***Timothy Osborn*[1]*, David Mooneyhan*[2]*, Randy Osborne*[3]*, James Rizzo*[4] *and Patrick Fink*[5]**

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With the passage and impacts to the northern Gulf Coast from major (and even small) hurricanes, coastal flooding of large expanses of coastal land areas have been increasing over the last several years. Through analysis and field studies in this, the need for better positioning and water level and storm surge monitoring accuracy has become apparent and imperative.

For the first time ever, NOAA and the States of Florida, Alabama, Mississippi, Louisiana and Texas have formed a consortium to install and increase the number of GPS based Continuously Operating Reference Stations (CORS) along the Gulf Coast and to enhance existing and new tide and water level stations with GPS CORS Stations as well.

With large areas of coastal Louisiana with elevations below three feet and with large coastal populations like Mobile, Biloxi, Galveston, Tampa (to name a few) with large vulnerabilities to tropical storms and hurricanes, this collaborative effort is very important.

This paper and presentation will detail the critical absence of accurate positioning resources to support the present and future population and economies of the Gulf Coast states. A description of the first phase of activities will be made and the overall goal of creating and maintaining a robust GPS based network along the Gulf for the measurement of land elevations, the tides and water levels along the Gulf and the support to enhance monitoring of storm surge impacting coastal populations and natural resources.

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NOAA- SEA LEVEL TRENDS- PUTTING SEA LEVEL RISE CURVES INTO OPERATIONAL PRACTICE

Tim Osborn *and Michael Michalski*
NOAA, Regional Office, Lafayette, Louisiana, USA

Established in 1807, NOAA is the oldest science office in America.One of the first missions of the Office of Coast and Geodetic Survey was the charting and mapping of the nation's coast.

NOAA's earliest work with Coastal Louisiana was in the 1840s with the establishment of benchmarks, tide stations and terrestrial mapping and hydrographic surveying of the coast. Establishing these reference points set a foundation in the measurement of the elevation of the coast, the water levels of the bays and Gulf and to allow the monitoring and adjustment of both the land and water elevations. This is very important in that Coastal Louisiana is an area of one of the world's highest relative sea level rates. Due to the natural abandonment of the coastal area from the decline of the Mississippi River Delta Lobes, these very relative sea level rise rates are a means for the tracking of the coast as it submerges back into the Gulf.

While NOAA, the USACE, USGS and others have and maintain graphs showing the present and future relative Sea Level Rise trends, this presentation will show how these graphs/trends are put into operational practice in coastal restoration and coastal protection efforts. By using a 5 year cycle of updates to a network of water level stations in Southeast Coastal Louisiana, NOAA is adjusting the value of water level datums- such as Mean Sea Level- upwards in a range of 1.3-2 inches every five years. When looking forward to the construction of a long lived coastal restoration project, seeing water level rises of 12-16 inches by the year 2050 is a reasonable outlook.

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SLR AND SUBSIDENCE EFFECTS ON THE COASTAL LANDSCAPE AND THE RISE IN VULNERABILITY TO COASTAL NATURAL RESOURCES, COMMUNITIES, INFRASTRUCTURE

***Timothy Osborn*[1]*, Jim Mitchell*[2] *and Darren Wright*[1]**
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The recent release of the 'National Climate Assessment of the United States' and the 'Global Sea Level Rise Scenarios for the United States National Climate Assessment' (December, 2012) provide a very carefully constructed review of the conditions, factors and various scenarios that the coastal resources of the United States may see in rising sea levels through the rest of this century.

For Louisiana, sea level rise and subsidence are cumulative impacts that are seeing a greatly accelerated rise of coastal water levels for the State. Indeed, the overall rate of rise for the State's coast is one of the highest in the world and will see a likely rise of water levels of over 3 feet in the next 80 year or so. With scenarios of sea level rise (not counting subsidence) of possibly 4-6 feet, this would mean the impact of all coastal communities in the coastal zone of Louisiana. The conversion of coastal marsh and wetland resources today is occurring at a huge rate not seen anywhere else in North America. As rise of water levels continues, and even accelerates, the loss of wetlands, communities and infrastructures will continue and affect a huge segment of the State's economy, population base, and efforts to preserve the remaining wetlands that exist today.

A review of the factors impacting coastal Louisiana will be provided and specific coastal areas of very high impact and loss will be a focus on the discussed. With likely rate increases of relative sea level rise, a specific part of the discussion will be made on areas and communities that will be impacted first and more severely than other areas in the near future.

DOWNLOAD THE REPORT: http://www.globalchange.gov/what-we-do/assessment
http://cpo.noaa.gov/Home/AllNews/TabId/315/ArtMID/668/ArticleID/80/Global-Sea-Level-Rise-Scenarios-for-the-United-States-National-Climate-Assessment.aspx

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SURVEYING AND UPDATING OUR OTHER COASTAL ENVIRONMENT- THE NORTHERN GULF HYDRO SURVEY PROGRAM OF NOAA AND THE CRITICAL ROLE IN HABITAT STUDIES, COASTAL RESTORATION SUPPORT, COASTAL PROTECTION AND COASTAL INUNDATION MODELS AND THE SUPPORT TO A HUGE NEARSHORE AND OFFSHORE NAVIGATION AND ENERGY BASE

***Timothy Osborn*[1]*, Jon Dasler*[2]*, Mike Hill*[2] *and Patrick Fink*[3]**

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While rapid coastal landscape changes are seen plainly along the Gulf Coast, and in particular- Louisiana, the coastal bays, nearshore and offshore areas along the northern Gulf are seeing rapid changes to both bathymetry, habitats and impacts to coastal barrier islands and headlands.

Charting and imagery to show these changes and to update present maps and charts of the northern Gulf has been a huge undertaking by NOAA and it's contract partners such as David Evans and Associates.

Using cutting edge sonar imaging equipment and the processing of the imagery in to large area views of the coastal and nearshore waters of the Gulf have shown large changes in water depths, the loss of water bottom habitats, the movement of sands and material across the bays and Sounds along the coast from storm events and hurricanes. Additionally, important habitats and marine species have been identified and mapped that previously had not been surveyed with the new techniques and degree of detail see possible and being used today.

A review of the overall Gulf Survey program will be made and an emphasis made, with examples, on the critical importance for the surveying and mapping of our coastal waters to support restoration and protection efforts, coastal flood models, and to support a large coastal and offshore industry.

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MANGROVE RESTORATION AND MIGRATION IN A CHANGING CLIMATE: CLIMATIC DRIVERS AND SHIFTING ECOTONES

Michael J. Osland *and Richard H. Day*
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Along the Gulf of Mexico coast, climate greatly influences coastal wetland restoration practices and outcomes. In this presentation, we illustrate the regional influence of climatic drivers upon coastal wetland ecosystems and examine how climate change may affect the long-term success of mangrove restoration efforts. We specifically examine the potential influence of winter climate change, freshwater availability change, and accelerated sea level rise. Coastal wetlands along the Gulf of Mexico straddle several relatively dramatic and ecologically-important climatic gradients. Across the region, the frequency and intensity of extreme winter events limits the expansion of mangrove forests into salt marshes in natural and restored wetlands. Along drier coastal reaches (e.g., the western Gulf of Mexico), mangrove abundance is limited by low rainfall and freshwater availability, which can produce hypersaline edaphic conditions. In addition to climate, sea level fluctuations dictate the landward extent of mangroves relative to upland and freshwater ecosystems. These regional and local abiotic gradients produce relatively dramatic coastal wetland ecological transitions. In the future, these ecotones are expected to migrate; winter climate change, freshwater availability change, and accelerated sea level rise are expected to produce conditions that will lead to poleward and landward mangrove expansion in parts of Texas, Louisiana, and Florida. In this presentation, we examine regional differences and discuss the role of climate drivers and shifting ecotones in the context of mangrove restoration practices and outcomes. Our results highlight the importance of incorporating climatic drivers (i.e., temperature and precipitation) into long-term coastal wetland planning and restoration efforts along the Gulf of Mexico coast.

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INCORPORATING SEA-LEVEL RISE IN LOUISIANA'S COASTAL MASTER PLAN

James W. Pahl
State of Louisiana, Coastal Protection and Restoration Authority, Baton Rouge, LA, USA

The State of Louisiana's Coastal Protection and Restoration Authority (CPRA) is required by the Louisiana Legislature to update *Louisiana's Comprehensive Master Plan for a Sustainable Coast* (hereafter Coastal Master Plan) every five years. The last iteration of the Coastal Master Plan, published by CPRA in 2012, made extensive use of a complex suite of project effects models to establish a 50-year, $50 billion strategy to design and build a portfolio of hurricane protection and coastal restoration projects predicted to result in a sustainable coastal zone.

The analytical effort in support of the 2012 Coastal Master Plan modeled project response to a number of critical environmental drivers. Those drivers included discharge and nutrient concentration of the Mississippi River, frequency and intensity of hurricanes, precipitation, evapotranspiration, and flooding- and saltwater-induced collapse of wetlands to open water. Multiple scenarios were run with different intensities of each driver to acknowledge that there exists a good deal of uncertainty in predictions of the intensity of these drivers.

The 2012 Master Plan analyses also studied eustatic sea-level rise (ESLR) and subsidence as components of relative sea-level rise (RSLR), one of the critical environmental drivers influencing coastal zone planning and the success of coastal protection and restoration projects. In southern Louisiana, variable but potentially very high rates of subsidence contribute to some of the highest recorded rates of RSLR in the United States. The plausible range and the individual scenario values for both ESLR and subsidence used in the 2012 Coastal Master Plan analyses were based on a robust examination of the scientific literature available in 2009, when that analytical effort was initiated. The assembled information is available in the Coastal Master Plan technical documentation on the CPRA website.

CPRA has begun the analytical effort in support of the next iteration of the Coastal Master Plan, which will be published in 2017. The technical team supporting the development of the 2017 Coastal Master Plan has carried forward the use of eight environmental variables driving the project effects modeling. This iteration will be conducted to help CPRA understand synergies and conflicts between projects identified in the 2012 Coastal Master Plan and help inform regional project implementation strategies. Accordingly, the technical team has initiated an update of the available technical information on past and predicted future ESLR and subsidence to determine whether updates to those plausible ranges and scenario values are necessary.

This process was ongoing at the time this abstract was submitted, but will be complete by June 2014. This talk will present a summary of the process of data development, as well as the findings of that effort and the draft decisions on the scenarios to be represented in the project effects modeling that will be conducted in support of the 2017 Coastal Master Plan.

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POLICY ISSUES AND RECOMMENDATIONS FOR THE IMPLEMENTATION OF BENEFICIAL USE OF MANAGED SEDIMENTS

Larry E. Parson
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Sediment management resulting from dredging activities generates a potential source of material that should be considered in any environmental conservation and restoration project. Wise use of sediment resources from dredging is integral to accomplishing the conservation and restoration initiatives and objectives being recommended under the Gulf of Mexico Alliance (GOMA). Keeping dredged sediments within the natural system or using it in the construction of restoration projects can provide valuable environmental benefits and contribute to habitat creation and restoration goals. Millions of cubic yards of sediments are dredged each year, much of which could be used beneficially. Roughly, only about 30 percent of material dredged from federal channels is used beneficially and even less of the privately funded dredging is used for beneficial purposes. The U.S. Army Corps of Engineers (USACE) conducts dredging under its navigation program and is typically done on a scheduled and routine basis. Utilization of this material requires planning and coordination involving multidisciplinary interagency teams.

Understanding the policies and funding issues associated with implementing beneficial use activities is a key element of the planning process. BU opportunities are very often missed as a result of funding limitations, frequent last-minute appropriations, and short-term decision-making on site-specific dredging activities. Getting a single beneficial use project through the planning, engineering, permitting, funding and construction processes can take years depending on the issues that have to be overcome. Statutory authorities, federal policies and funding constraints are often cited as obstacles to implementing beneficial use opportunities within the Gulf States.

Under GOMA, the Gulf Regional Sediment Management Master Plan (GRSMMP) was developed to provide guidance for implementing regional sediment management throughout the Gulf States and initiated discussions pertaining to authorities, policies, and funding mechanisms relevant to dredging activities that affect the implementation of regional sediment management actions and restoration projects. Included in the GRSMMP is a focus on looking at ways to leverage existing authorities and policies, as well as recommendations to make them more flexible to facilitate implementing beneficial uses of managed sediment.

The Water Resources Development Act (WRDA) of 1986 brought about a major evolution of law and policy concerning the beneficial use of dredged material. Laws have been established providing Federal authorities to use dredged material for environmentally beneficial purposes. Challenges still exist to providing greater insight into ways to work within existing policies and authorities and how to make them more flexible to facilitate an increase in the implementation of beneficial use projects.

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RESTORATION IN THE MISSISSIPPI RIVER DELTA: OLD RIVER CONTROL STRUCTURE TO THE GULF OF MEXICO

***A. Carol Parsons Richards**, Bren Haase, Natalie Peyronnin, and Many Green*
Coastal Protection and Restoration Authority of Louisiana, Baton Rouge, LA, USA

Louisiana contains one of the largest expanses of coastal wetlands in the contiguous United States. These coastal wetlands, built by the deltaic processes of the Mississippi River, contain an extraordinary diversity of habitats ranging from beach ridges to expanses of forested swamps and freshwater, intermediate, brackish, and saline marshes. These diverse habitats support millions of migratory waterfowl and songbirds and allow for one of the most productive commercial and recreational fisheries in the nation. In addition, these wetlands support one of the largest complex of deep-draft ports and one of the highest production of oil and natural gas in the United States. Unfortunately, loss of these coastal wetlands has been occurring since the early 1900s and 1880 square miles have been lost since the 1930s. This land loss and the associated degradation of the coastal ecosystem are the result of both natural and human induced factors. Subsidence, storms and hurricanes, and canals associated with navigation and oil and gas exploration are a few of the many contributors to this loss. Another contributing factor to Louisiana's coastal wetland loss is the hydrological isolation of the coastal wetlands from the freshwater, nutrients and sediments contained in the Atchafalaya and Mississippi Rivers that would otherwise build, nourish, and sustain these wetlands. While natural crevasses and historical overbank flooding of the Mississippi River historically deposited sediments and nutrients that gradually built up and maintained Louisiana's wetlands, levees constructed on the Mississippi River primarily after the Flood of 1927 effectively isolated the river from the surrounding wetlands.

Projects have been constructed over the past 40 years by a number of restoration programs and a variety of non-governmental organizations, not-for-profit organizations, and local, state, and federal governmental agencies in an effort to reduce Louisiana's coastal land loss and restore some of the habitats that have degraded. Restoration project types have included barrier island restoration, ridge restoration, marsh creation, shoreline protection, terracing, vegetative plantings, river diversions, and hydrologic restoration. Some of the most critical projects currently planned will reconnect the Mississippi River with the coastal wetlands through sediment diversion projects to re-establish deltaic processes that have been anthropogenically discontinued. The Coastal Protection and Restoration Authority's 2012 *Louisiana's Comprehensive Master Plan for a Sustainable Coast* has proposed ten diversion projects for implementation, some with larger discharge capacities than previously pursued. This presentation will focus on coastal wetland restoration projects that have been constructed in Louisiana over the past decades and will emphasize how the State of Louisiana intends to leverage the Mississippi River as a restoration tool.

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AUTOMATED ONLINE ECOLOGICAL MODELING AND EVALUATION FOR EVERGLADES MANAGEMENT AND RESTORATION

Leonard Pearlstine[1], *Suresh Goldconda*[2], *Kevin Suir*[3], *Alicia LoGalbo*[1], *Craig Conzelmann*[3], *Janice Parsons*[1]
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An automated web server-based decision support framework has been developed for data acquisition from external sources, evaluation modeling, and rapid display of spatiotemporal ecological model results, summary evaluation graphics and reports. The tool is designed with flexibility that encourages its use as a standard framework for future additional evaluations of ecological modeling. The pilot implementation integrates a wading birds evaluation module that serves the immediate needs of resource management in the Everglades. The framework acquires and preprocesses monitoring data from multiple external sources to perform weekly ecological model evaluations. Data delivery occurs online via dynamic web pages that offer users the ability to view and compare past generated maps, as well as access the underlying numeric data, along with explanatory text about the model evaluation method and the generated maps. Each web page will be constructed in a way that allows the inclusion of its content on multiple web sites, facilitating wider availability and ease of access across the user community.

Wading birds are a high priority indicator with a well-established and analyzed dataset that is linked tightly to surface water hydrology. Surface water hydrology data is readily available online from the Everglades Depth Estimation Network (EDEN) as daily real-time, interpolated water-level gage data for the entire freshwater portion of the Greater Everglades from 1991 to present and is updated online every few days. Synthesis of model evaluations of spatial trends for these and other indicators of ecological health in easily accessible and understandable formats increases the likelihood it will be included in water management operations and other decision-making, thus completing the monitoring-management-action feedback loop. The weekly wading bird reports provide valuable information for multi-agency tasks meetings evaluating water operations in the Everglades and contribute to the adaptive management goals of the Comprehensive Everglades Restoration Plan. The technology to accomplish this decision support tool should be of interest to other monitoring programs across the country where there is interest in a making data and analysis results available more quickly via the web. The results should be of use to planners, modelers, operations managers, researchers, park interpretive staff, and all stakeholders interested in the effectiveness of the Everglades Restoration.

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ENGINEERED ECOSYSTEMS, A CYBORG APPROACH TO ECOSYSTEM RESTORATION - *GRAND LAKE ST. MARYS LITTORAL WETLAND RESTORATION*

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Ecosystems processes fluctuate wildly when under stress of changing physical, climatic, biological and anthropogenic inputs as the system seeks to attain equilibrium. They are expressed in the ecosystem through declines in ecosystem services (species abundance/diversity, water quality, flood pulsing, etc.). The amplitude of these fluctuations is symptomatic of the severity of the problem, and predicative of system collapse. Re-establishing the equilibrium within the ecosystem to restore the services it provides, is the basic premise of ecological restoration.

Direct modification of an ecosystem as a whole is beyond the technological, physical and financial limitations of society. However, the resilience of the processes within the ecosystem can be used to synergize an effect on the system as a whole given proper nurturing and support. The initiation of this process may require establishing a symbiotic relationship between engineered systems and natural infrastructure specifically designed and calibrated to enhance targeted ecosystem processes that will yield exponential response within the ecosystem. The created "cyborg system" serves the greater good of the objective by establishing seeds of stable processes that become the foundation for self-sustaining ecosystem restoration.

This approach is being applied to the restoration of the Grand Lake St. Marys (GLSM) Ecosystem. Nutrient loading from the contributing watershed has created hypertrophic conditions within the 21 square mile lake ecosystem. Radical swings in water clarity and temperature fuel massive blue green algae blooms that create a cascade of impacts to system processes, disrupting biological, chemical, and societal services provided by the lake. The frequency and severity of the blooms indicated the system was on the verge of ecological collapse.

GLSM historically supported 2,500 acres of littoral fringe wetlands that maintained a healthy equilibrium, processing nutrients and providing habitat. Loss of the littoral wetland system through anthropogenic actions and invasive species (carp) stressed the system to the breaking point. As a component of the ***Critical Response Actions*** and ***Conceptual Ecosystem Revitalization Model*** established by the ***Strategic Plan*** for the lakes restoration, Engineered Ecosystems were established to address the limiting factor to the restoration of the littoral wetland system by targeting water quality degradation.

These systems remove nutrients via a series of interlinked engineered, bio-technical, and natural treatment systems. Water is pumped through the system at the rate of several million gallons per day, the water is treated by a series of systems including alum injection, constructed wetlands, and restored naturalized wetlands, prior to being discharged back into the lake through a embayment/constructed littoral wetland. The improvement in water quality provides the conditions needed for natural regeneration of littoral wetlands beyond the influence of the engineered systems. Natural re-establishment of littoral vegetation in the embayment and constructed littoral wetland system provides direct evidence of the effectiveness of this approach.

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THE LOUISIANA FRESHWATER ASSESSMENT: SCIENTIFIC DECISION SUPPORT FOR FRESHWATER CONSERVATION AND POLICY DEVELOPMENT

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Louisiana is a water state. With over 125,000 miles of rivers, bayous, and streams and abundant annual rainfall, water has been and will continue to be important to our economy, culture, and fish and wildlife resources. The future sustainability of Louisiana's natural resources, its drinking water, and economic development, will be underlain by assurance of a high quality and sustainable freshwater supply. While Louisiana's water wealth has been taken for granted, evidence is beginning to suggest that continued abundance of fresh water in Louisiana may not be a foregone conclusion, and decisions made regarding freshwater resources (e.g., residential and industrial development, water transfers and sales) will affect citizens, economic development, fish and wildlife, and coastal resources.

These factors illustrate the need for sustainable water planning in Louisiana – a task that is just beginning. While the end result of water planning is unclear, it is imperative to have quality scientific information and science-based decision support regarding, among other things, status and trends of surface and groundwater resources, river and stream flow, current and future water use, sources and locations of freshwater threats, and linkage of freshwater and coastal systems.

We describe the Louisiana Freshwater Assessment (LFA), an evaluation of watershed health, including landscape integrity (i.e., land use and cover, floodplain connectivity, channelization), water quality, and biological health (i.e., trends in species diversity indicators,) of Louisiana's watersheds. We also describe: statewide surface-flow modeling and linkage with existing groundwater models to simulate hydrologic interactions between surface waters and deep aquifers. Lastly, we preview a suite of streamflow metrics and decision-support apps that represent measures of hydrologic resilience, alteration, stream health, and the impact of groundwater pumping on surface water flows.

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THE DETAILS OF REAL-TIME REPORT CARDING THROUGH LOUISIANA'S COASTWIDE REFERENCE MONITORING SYSTEM

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In 1990, the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) was passed by Congress which authorized funding for planning and implementing restoration projects in the Louisiana coastal zone. An important component of CWPPRA is a 20-year investment in monitoring the effectiveness of individual projects and providing an assessment of the cumulative effects of all restoration and protection projects on the coastal landscape. The Coastwide Reference Monitoring System (CRMS) is a single comprehensive wetland monitoring program that allows for ecological comparisons at site, project, hydrologic basin and coastwide scales. The CRMS network contains 390 1-km^2 sites throughout the Louisiana coastal zone with each site providing monitoring data on a consistent suite of water, vegetation, soil, and landscape parameters at multiple temporal frequencies.

Historically, large regional monitoring programs have had problems effectively delivering data and analytical products to the end-users in a timely fashion because data management teams commonly operate separately from the scientists, researchers, and resource managers. The CRMS program developed analytical teams that consist of scientists and information technology specialists. The teams work together to develop analytical products that are based on the needs of the natural resource user community and to deliver data in a spatially enabled web environment. Once data are accepted into the database they are immediately available to users. There is no lag between data acceptance into the database and visualizations on the website.

The CRMS analytical teams developed a set of indices (i.e., floristic quality, hydrologic, and submergence vulnerability) that are presented in CRMS report cards. The CRMS report cards incorporate the indices and land:water analyses to assess the effects of restoration projects at multiple scales using data from project and reference sites within the CRMS network. This talk will present the development of the CRMS indices and the multi-scale assessments available through the CRMS report card. The CRMS report cards are available in real-time on the CRMS website and are generated “on-the-fly” so that assessments are based on the most current data (http://www.lacoast.gov/crms).

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COMMUNITY DRIVEN WATER QUALITY IMPROVEMENT TO BENEFIT GULF ECOSYSTEMS: EPA FUNDED PROJECTS 1987-2013

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Clean water is an important indicator of health for human communities (Allee, et al., 2010) as well as in Gulf ecosystems (Gulf Coast Ecosystem Restoration Task Force, 2011). EPA has funded hundreds of projects and partnerships in the Gulf region that have directly improved water quality and increased ecosystem health. These projects and partnerships have resulted in the removal of coastal segments from the impaired water body list [303(d) listing] creating long-term gain. They have also solidified partnerships that continue to improve Gulf ecosystem water quality long after individual project funding has been exhausted.

EPA funded partners like Alabama Water Watch (AWW), the Lake Pontchartrain Basin Foundation (LPBF), Mississippi REACH and the long-term successes of the National Estuary Programs (NEPs) have been able to use EPA funding to make significant positive changes in waters that drain to the Gulf. These partners have removed nutrient contamination, reduced harmful bacterial levels and brought Gulf state watershed partners together to accelerate adoption and change. They build on the legacy of community efforts that began with the modern environmental movement.

The AWW partnership has used community collected water quality data for 22 years to convince local officials to make improvements in infrastructure to improve waters draining into the Gulf and more recently in Mexico through Global Water Watch. AWW has additionally worked with farmers/ranchers to make land management changes that have shown measurable improvements in water quality. For 25 years, the LPBF partnership has used water quality data to work with partners on best management practices and proper permitting of wastewater treatment that has resulted in the removal of impairments to several streams that feed the Lake Pontchartrain estuary. One of EPA's newest co-supported partnerships, Mississippi's REACH, has used farmer led efforts to implement edge-of-field water quality testing in concert with low technology farm best practice solutions. Programs like REACH have much promise for expansion as farmers see the benefit of using water quality data to show their pro-active, voluntary efforts work to protect ecosystems while maintaining economic vitality. Gulf NEPs and their partnerships have resulted in many thousands of acres being protected and restored in the Gulf while also leveraging base EPA funding by approximately 15 times. Individually and collectively, partnerships like those mentioned show the scale and longevity of water quality improvement efforts in the Gulf with many challenges and success stories along the way.

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APPLICATION OF A HABITAT CONSERVATION PLAN TO LARGE-SCALE ECOSYSTEM RESTORATION AND WATER SUPPLY RELIABILITY IN CALIFORNIA: THE BAY DELTA CONSERVATION PLAN

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Habitat conservation plans as a tool under the Endangered Species Act have been in existence since 1982. Despite over 600 plans being approved in the United States, few have addressed complex water resources planning issues on a large scale. A wave of federal listings are expected as a result of a 2011 Settlement Agreement with the U.S. Fish and Wildlife Service to consider over 700 species nationwide, most of which occur in aquatic environments, increasing the need for conservation planning tools that address multiple listed species. Habitat conservation plans applied to aquatic ecosystems are relatively rare. The pros and cons of the habitat conservation plan model are considered in the context of the Bay Delta Conservation Plan in California, one of the most complex aquatic HCPs ever attempted.

The Bay Delta Conservation Plan would restore over 100,000 acres of tidal and non-tidal wetlands in the highly degraded ecosystem of the Sacramento-San Joaquin River Delta, the largest inland delta in the Western Hemisphere. This restoration program would be the largest in western North America and would benefit 11 listed and non-listed native fish and over 45 terrestrial species. The plan would also restore and stabilize water supplies to the State Water Project and federal Central Valley Project, the largest publically-owned and operated water systems in the world. The Sacramento-San Joaquin River Delta is the hub of the system that provides water for over 25 million residents and 3 million acres of highly productive agricultural land. One of the key actions of the plan is the construction of dual 30-mile-long tunnels under the Delta and a new point of diversion that would help to restore a more natural flow pattern and greater variability in Delta hydrology, benefiting native species. At a cost of $24.7 billion, the plan is a significant investment by the public and by the state and federal water contractors who use the water system. The expected benefits and challenges of implementing the plan will be discussed, providing lessons for the use of habitat conservation plans to facilitate large-scale ecosystem restoration.

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HOW PLANTS ESTABLISH, OR FAIL TO, IN RESTORATION PROJECTS

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Seedlings face a myriad of challenges after outplanting before they can become established and grow. Often, these situations pose significant limiting factors that are not typical in normal native plant regeneration. These challenges are realized by land managers after a thorough site evaluation that includes biological, physical, spatial, and temporal factors. Only then can the primary limitations to establishment be understood and consequently overcome. In most cases, the primary limitation to seedling establishment is moisture availability, but other limiting factors might include: other plants, animals, extreme temperatures, lack of microorganisms, and even social/cultural issues. To further our understanding of how seedlings engage their surroundings and begin to survive and grow on a site, a model of seedling establishment has been developed. This model characterizes the physiologic, atmospheric, and edaphic process that factor into a target seedling's design and the supplemental appropriate mitigating measures that need to be employed. The Target Plant Concept further helps characterize mitigating measures such as site preparation and stocktype selection, along with high quality seedlings, that will help establishment. In restoration, this often requires novel approaches and development of new tools and techniques. This presentation will discuss site evaluation, limiting factors, and mitigating measures (including target plant material and site preparation) using research and case study information.

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APPLICATION OF A SALINITY PERFORMANCE MEASURE FOR EVERGLADES RESTORATION PLANNING

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Participants in the Comprehensive Everglades Restoration Plan rely on a suite of performance measures to evaluate restoration alternatives and assess empirical data to determine the status of the ecosystem. These performance measures include both physical and biological indicators. Recently, the salinity performance measure for Florida Bay at the southern end of the Everglades ecosystem domain was significantly revised and approved for use. In 2013 this performance measure was used to evaluate restoration alternatives of the Central Everglades Planning Project (CEPP)—a component of the larger Everglades restoration planning effort. The goal of the CEPP is to identify and plan projects on lands already in public ownership to allow needed freshwater to be directed south from Lake Okeechobee to the central Everglades, Everglades National Park and Florida Bay. The purpose of this presentation is to describe the use of this performance measure in evaluating planning scenarios for CEPP.

The Florida Bay salinity performance measure is comprised of three metrics, including salinity mid-range, hypersalinity, and mean salinity difference metrics. The target for each of the metrics is a 36-year time series simulation of the salinity regime in Florida Bay prior to water management changes that altered salinity conditions. The target time series are produced at 19 sentinel sites in Florida Bay using model simulations that are adjusted based on paleosalinity information. For each performance measure metric, salinity output from CEPP model simulations of project alternatives are compared against the target, the existing condition baseline, and the projected future without project scenario. Results indicate that the performance measure is sensitive enough to differentiate between project alternatives sufficiently to aid planners in selecting a preferred project alternative. As an additional application the output from the performance measure was applied spatially across Florida Bay to yield project benefits in terms of habitat units. This performance measure and the manner in which it is used are applicable to any estuarine system. To aid managers and non-scientists in the interpretation of results, the performance measure output can be also translated into a “stoplight” report card.

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NATURAL PROCESSES FOR SHORELINE STABILIZATION

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Natural ecological processes have been providing dynamic stability to shoreline ecosystems for millennia. Understanding how these processes operate allows restoration programs to be modeled on these processes thus gain the benefits of working within these processes. Shorelines are dynamic places where building flexibility into the restored shorelines provides conditions that are responsive to changes in flows and water levels. By understanding the mechanisms underlying the degrading processes, natural systems can be designed that address these degrading processes. Many of the natural shoreline defenses use strength in numbers as the foundation of their effectiveness. A bed of emergent aquatic vegetation (e.g. *Typha*) may contain thousands of separate stems, none of which are very strong individually, but together can provide effective damping of wave energy. By maintaining a level of flexibility as well as the ability to re-grow when damaged, natural systems of shoreline protection are often much more effective than traditional engineering solutions. Many soil bioengineering systems are based on these natural designs. Understanding how natural systems address dynamic sites such as shorelines can offer solutions for humans to use. Wave erosion is one of the common shoreline problems. In only a very few cases are course rocks (e.g. rip-rap) used by natural shorelines to solve wave erosion. Emergent aquatic vegetation, either herbaceous such as cattails and bulrushes or woody such as willows, is commonly found growing along shorelines. These protect the shore from the impact of waves. Clearing this important vegetation and building a lawn to the beach is an invitation for erosion. Natural systems provide the solutions to these problems.

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ACCOUNTING FOR PRIVATE BENEFITS IN TARGETING ECOLOGICAL RESTORATION

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Opportunity cost constitutes a substantial component of the costs of ecological restoration projects undertaken in agricultural landscapes, especially when the majority of land is privately owned. In past studies, opportunity cost in ecological restoration studies have been accounted for using property values or capitalized values of agricultural production. These approaches assume acquisition of land for ecological restoration projects. However, when ecological restoration is conducted on private lands without alienation, the opportunity cost could be different (lower) because the landowner retains ownership of the land and captures part of the benefits generated by restored ecosystem, such as amenity from native vegetation. Yet, we are not aware of any study that factors private benefits into the optimization of ecological restoration. Furthermore, due to diminishing marginal value of privately captured benefits of ecosystem services, the marginal opportunity costs of landscape reconstruction will be increasing with the size of ecological restoration project.

In this study, we compare the implications of using different assumptions about private benefits and opportunity cost on the optimal spatial pattern of ecological restoration of a cleared agricultural landscape in north-central Victoria, Australia. We estimate the marginal values of native vegetation (representing private amenity benefits) and the marginal values of agricultural land (representing opportunity cost) from the property sales data using a spatial hedonic model. We employ a spatially explicit bio-economic model that optimizes ecological restoration through revegetation of a cleared landscape. It incorporates detailed functions of species' responses to spatial pattern and ecological heterogeneity of existing and restored native vegetation. The model determines spatial priorities for ecological restoration by maximizing the abundance of woodland-dependent birds subject to budget constraints.

We compare implications of using different assumptions about opportunity cost: (a) fixed marginal opportunity costs based on property value, and (b) variable marginal opportunity costs that take into account land value and private benefits generated by environmental assets on the property. Using variable marginal opportunity costs that account for private benefits captured by the landowners gives a better biodiversity outcome than using fixed marginal opportunity cost subject to the same budget constraints. Spatial patterns of ecological restoration of these scenarios differ substantially, with ecological restoration pattern shifted towards smaller properties (lifestyle landowners) in the variable-marginal-value scenario. Our results show that in order to avoid providing misleading recommendations to environmental managers, it is important to take into account amenity values of native vegetation and variable opportunity cost while prioritizing ecological restoration on private lands.

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OVERCOMING BARRIERS TO WETLAND RESTORATION – AN INTERNATIONAL PERSPECTIVE

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Coastal habitats play an important role in reducing coastal flooding and erosion risks as well as creating valuable habitats. Restoring coastal habitats can therefore play an important role in the management of coastal areas. Nevertheless the implementation for such schemes is not always straightforward. This paper explores some of the most common challenges that are faced when trying to implement wetland restoration schemes in the coastal zone. It draws upon experiences from the UK and US and shows how these barriers have been overcome and the areas where further creative thinking is needed in the future.

In England it is estimated that some 32,125 acres of coastal habitats were lost from 1945 to 2000 due to a combination of development, conversion to agricultural land and coastal erosion. A further 163,090 acres of habitats are estimated as being at risk due to rising sea levels. Over the last 15 years some 4,200 acres of replacement habitat have been created in 62 coastal wetland restoration schemes. However, in order to achieve the policies laid out in long term strategic coastal management plans (11,500 hectares by 2060), the current rate of delivery needs to double. Delivering this amount of habitat will be challenging for a number of reasons including: (1) ensuring the long term viability of habitats within schemes, (2) gaining stakeholder support for changes in land use, (3) demonstrating robust economic cases for schemes, (4) mitigating for displaced freshwater habitats.

In the United States, estuarine vegetated wetlands are being lost at a rate of 25,000 acres/year and greater than 80% of the wetland loss results in a conversion to open water. The highest rate of loss occurs in Louisiana, where 10,000 acres of wetlands are lost each year. To deal with this Louisiana has produced a 50-year coastal restoration master plan, with projects that can build and maintain 320,000 acres of coastal wetlands and landforms. The primary project types include direct wetland creation with dredged sediments and diversions from the Mississippi River to restore more natural delta wetland building. Individual wetland creation projects are typically 500 acres and current annual rates of delivery are approximately 3,000 acres/year. Sediment diversions are planned with capacities ranging from 50,000 to 250,000 cfs. Diversions yield the greatest benefits to land building and sustaining existing wetlands. With adequate funding (>$50B) the projects are projected to reduce annual flooding damage by $5-18 B. Accommodating navigation, industrial water needs, and traditional commercial fishery grounds, represent some the greatest challenges to bold strategies such as re-aligning the lower Mississippi River for long-term landscape and economic security.

This presentation will illustrate how these challenges have been overcome in the schemes that have been developed to date in the UK and the US. The presentation will also demonstrate the potential role of ecosystem service assessments in engaging stakeholders and demonstrating the financial worth of such schemes.

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CASE STUDIES OF THE BALTIMORE SECOND HARBOR PROJECT

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In 2011, twelve federal agencies joined forces with a diverse group of organizations to conduct seven pilot projects around the country. Known as the Federal Urban Waters Partnership, the mission was to help urban communities restore their rivers, lakes, wetlands, bays, and oceans. To achieve this mission in the Middle Branch area of Baltimore, a partnership has been established between the Wildlife Habitat Council (WHC), The Parks & People Foundation (PPF), the U.S. Forest Service (USFS), and corporate partners that make up the Baltimore Second Harbor Project.

The project involves 4 phases from a start-up phase in Baltimore to dissemination as a national model. The Wildlife Habitat Council has established that working with corporate partners and other private landholders in the implementation of habitat enhancement and remediation efforts is imperative for the realization of effective, sustained ecological outcomes. With initial funding from the U.S. Forest service and support from other project partners, WHC has implemented a series of projects addressing land use issues that impact water quality and biodiversity as well as broader community priorities such as recreation opportunities, public health, community revitalization and economic development. Several case studies of projects done as part of the Baltimore Second Harbor Project will be explored and discussed, demonstrating the positive ecological and community benefits that can result from working with corporations.

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JOHNSON'S SEAGRASS – INTRODUCED EXOTIC OR RARE ENDEMIC SPECIES?

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The seagrass *Halophila johnsonii* is limited to the east coast of Florida where it occurs from Biscayne Bay to the south and Sebastian Inlet to the north. The first record of this species was published by Phillips (1960). At the time he identified this species as *H. baillonis*. It was later described as a new species by Eiseman and McMillan (1980). Because of its limited distribution and numerous potential anthropogenic insults the National Marine Fisheries Service (NMFS) listed this species as Threatened in 1998 under the US Endangered Species Act (ESA) with Critical Habitat Designation occurring in 2000. This was the first and is the only seagrass species listed under the ESA. However, during the initial listing status review there was some concern voiced by the seagrass scientific community that the species might be an introduced, exotic species and therefore, should not be afforded protection under the ESA. This concern was based on its limited range coupled with the clonality, mode of growth, life history, dispersal mechanisms, population dynamics, physiological ecology, and phylogeny of the species – a concept strengthened by the fact that at the time of the listing in 1998, only female plants had been found. York et al. (2008) further noted that although only female flowers have been identified there is no known seed production in the ovules due to pollination failure. York et al. (2008) concluded that *H. johnsonii's* female gametophytes are structurally viable. Thus, if male flowers were present they could potentially reproduce sexually. If *H. johnsonii* is a viable species, where are the male flowers? More recently, the controversy as to this species status has increased as genetic analysis has revealed that *H. johnsonii* is genetically very similar to *H. ovalis* (using nrDNA sequences) , which is an Indo-Pacific species (Waycott et al. 2006, Short et al. 2010). These new discoveries strongly suggest that *H. johnsonii* may in fact be an introduced representative of *H. ovalis*. New ecologic information collected on this species shows that it is; (1) the first seagrass to colonize disturbed shallow areas, (2) the population has been increasing in many parts of its known range, and (3) the northward expansion of its boundary primarily through the fragmentation of a single clone all lends additional credence to this speculation. Because *H. johnsonii* reproduces asexually via fragmentation and does so year round, it has the ability to form long-lived, potentially "immortal" seagrass beds. In Florida, this species may in fact be an aggressive nuisance species displacing and outcompeting native seagrasses, especially in shallow water. Recent discovery of a small population of genetically identical *H.johnsonii/H. ovalis* samples from Antigua in the Caribbean (Short et al. 2010) appear to confirm the introduced, exotic nature of this species. Due to these and other factors, in 2010 the IUCN listed *H. johnsonii* as a species of Least Concern on their Red List of Threatened Species – directly contrary to the ESA listing. How we interpret *H. johnsonii,* native or exotic, can thus have far-reaching implications on how we are to manage this species. In light of all the scientific information presently available, it is strongly urged that the NMFS critically re-evaluate the ESA status of this species.

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REBUILDING CORAL REEF STRUCTURE AND COMPLEXITY FOLLOWING ANTHROPOGENIC DISTURBANCE

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Restoring severely degraded coral reef ecosystems requires an understanding of the factors that have caused their degradation. Reefs are disturbance-structured systems that often exhibit catastrophic phase shifts in community structure. For instance, the loss of reef structure following the injuries caused by vessel groundings can lead to long-term shifts in community structure that often recover to an alternate community state. Many restoration efforts fail to recognize the importance of structural complexity, instead focusing only on coral propagation and transplantation. However, for these communities to recover back to their original baseline state, restoration ecologists need to rebuild this lost structure and biological complexity to jump-start the natural recovery process. While this management action is founded in ecological theory, it is important that these actions need to be rigorously debated and that the arguments be grounded on good empirical data. With this in mind, it should be evident that the science of "complexity" is the cornerstone of the coral reef restoration process. Management interventions to "rebuild" natural communities are also most likely to succeed if they are able to mimic natural processes of community assembly and organization. Thus, if properly designed and executed, structural restoration will significantly reduce the recovery period of severely disturbed reefs and provide the foundation upon which successful reef restoration projects are based.

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ISOLATING MECHANISMS OF INVASION: EXPLORING THE LINK BETWEEN *RUELLA SIMPLEX* AND STORMWATER-IMPACTED SOILS

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Understanding mechanisms behind the invasibility of habitats is critical to restoring invaded natural lands. While nutrient enrichment from urban runoff has been shown to facilitate weed invasion, there are also instances of the plants themselves causing nutrient enrichment and promoting further invasion of the species. *Ruellia simplex* (Mexican petunia) is an invasive weed associated mainly with urban-wildland interface riparian wetlands. Despite identification as a Florida Exotic Pest Plant Council Category I invasive plant species, defined as displacing native plant communities and altering ecosystem functions, little is known about this species and its association with stormwater-influenced soils. A survey revealed differences in soil characteristics between *R. simplex*-invaded and uninvaded sites, e.g. comparatively higher pH in *R. simplex* invasions. It is unclear if *R. simplex* invasion is the result of these differences or the cause of them. To explore the role *R. simplex* plays in creating these differences, a greenhouse experiment evaluated effects of the species on soil. Soil collected from uninvaded areas was seeded with *R. simplex*, *Juncus effusus* (soft rush), *Solidago fistulosa* (pinebarren goldenrod), or left to allow extant seed bank to emerge. Soil was analyzed after five months for nutrients, pH, and organic matter. Few differences were found, suggesting that *R. simplex* does not have a strong modifying effect on soil. It may be that *R. simplex* does modify soil, but more than five months is needed for modifications to occur. If true, plant removal alone may be sufficient for restoration if action is taken early in the colonization process. However, based on the results from this study it appears soil degradation from stormwater runoff plays a larger role than soil modifications from *R. simplex* in facilitating invasion. Land managers may then be able to use the presence of *R. simplex* as an indicator of soil health. Results from this research are significant in that *R. simplex* invasions may serve as a model study system to isolate mechanisms of invasion for weeds of natural and agricultural areas.

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ALTERNATIVE SHORELINE MANAGEMENT IN COASTAL MISSISSIPPI

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Mississippi is home to 370 miles of coastline including beaches, bayous, rivers, and islands as well as 436,000 acres of estuarine wetlands comprised of 65,453 acres of tidal wetlands and 370,547 acres of non-tidal wetlands. (NOAA/OCRM. Evaluation Findings for the MCP from 11-96-01-02. December 2002) Mississippi's shorelines are instrumental to the ecological and economic health of the coast. The intertidal zone where water meets the land is a diverse and productive ecosystem, which provides foraging, breeding, and sheltering opportunities to many coastal species. These coastal species provide the residents of the Mississippi Gulf Coast with recreational and commercial fishing opportunities. The Mississippi commercial seafood industry accounted for more than $231 million in sales in 2011. Recreational fishing provided nearly $146 million in sales in 2011. (Gulf State Marine Fisheries Commission, 2011)

Coastal shorelines have changed and eroded as a result of natural processes governed by climate, geology, ocean currents, waterbody depths, and wind. In addition to natural factors contributing to erosion and shoreline change, coastal development and human activities have exacerbated these changes. Efforts to prevent or control erosion must be balanced with ecological impacts and costs. The overwhelming response to shoreline erosion in Mississippi has been to protect the shorelines through bulkheads or other hardening strategies. These hard structures reduce habitat by separating land from water interfaces. They also reflect waves off the shoreline to unprotected areas, causing erosion of the land below the bulkhead and increased water depth at the shore. (MS-AL Sea Grant. Shoreline Protection Alternatives. MASGP-070026)

To balance shoreline protection and ecological preservation, the MS Department of Marine Resources has developed a guidance manual for property owners and government agencies to provide information and education regarding alternative shoreline management practices. The manual highlights alternative shoreline management strategies, including living shorelines and hybrid stabilization projects, may be the most cost-effective, attractive and ecologically sensitive.

To help disseminate the information, a stakeholder engagement campaign was also developed. The presentation will provide an overview of the engineering, planning, and scientific considerations addressed in the Coastal MS Alternative Shoreline Management Manual. In addition, the Coastal MS Stakeholder Engagement Campaign will be presented.

Benefits of Living Shorelines include the following: Increased fish/wildlife habitat; Increased property value; Reduced erosion; Reduced pollution through natural buffers/filters; Created sense of place; Improved water quality; and Cost-savings.

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CHESAPEAKE BAY WATERSHED MODEL ANAYSIS OF CLIMATE CHANGE MODEL PREDICTED PRECIPITATION, TEMPERATURE, AND POTENTIAL EVAPOTRANSPIRATION EFFECT ON STATE-BASIN NUTRIENT AND SEDIMENT LOADINGS

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In 2010, the EPA established the Chesapeake Bay Total Maximum Daily Load (TMDL), a federal "pollution diet" that sets limits on the amount of nutrients and sediment in order to meet water quality goals. To ensure the TMDL is met, the jurisdictions use Watershed Implementation Plans (WIPs), two-year milestones, monitoring, and an integrated modeling system to track and assess progress toward completing the restoration actions. The Chesapeake Bay Program (CBP) integrated models include simulations of the airshed, watershed, estuary, and living resources. These integrated models assess effects of current and proposed watershed management on changes in nutrient and sediment loads delivered to the Bay, and the effect those changing loads have on water quality and living resources. In order to obtain and then continue to meet water quality standards, the CBP and its partners must understand the consequences of climate change and consider climate change as an integral part of decision-making. Effects of climate change, such as sea level rise and increased temperatures, have already been recorded in the Chesapeake region and throughout the world. Other possible impacts of climate change on the Bay include lower dissolved oxygen levels, more precipitation, and changes in wildlife abundance and migration patterns.

This study uses the HSPF (Hydrological Simulation Program Fortran) Watershed Model Phase 5.3.2 to investigate the fate of hydrology and nutrient and sediment transport as part of an ongoing climate change study. The precipitation, temperature, and potential evapotranspiration output of six General Circulation Models was used to create input for the climate change runs. 10-year hydrological simulations were conducted: 1990 – 1999 for the baseline scenario and 2086 – 2095 for the climate change scenarios. The Chesapeake Watershed Model is divided into 368 land segments and over 2000 river segments. Each land segment has specific natural characteristics, nutrients applications, and land uses. There are thirty different land-uses, 25 pervious and 5 impervious, such as farmland with high-till and manure application. This analysis examines the spatial variability in flow, nitrogen, phosphorus, and sediment loadings due to the impacts of climate change at Chesapeake Bay watersheds at the statebasin scale.

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CREATING & SUSTAINING A GOVERNMENT ECOLOGICAL RESTORATION PROGRAM

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The Massachusetts Division of Ecological Restoration (DER) was created in 2009 with the merger of two community-based, natural resource protection programs. DER is a Division within the Commonwealth of Massachusetts' Department of Fish and Game. The Division coordinates ecological restoration to improve habitat for wildlife and to restore important ecosystem services that improve quality of life.

DER defines restoration broadly and inclusively. Restoration encompasses activities that not only help to restore and enhance ecological functions and values through physical actions, but includes education and technical assistance that leads to protection and preservation of ecosystems. Successful restoration results in ecosystem integrity, resiliency, repair, revitalization and remediation. Certain activities do not meet the definition of ecological restoration and are not pursued – these are based largely on the inability of actions to result in ecosystem self-sustainability, excessive reliance on operation and maintenance or actions that benefit select wildlife species only.

With a focus on aquatic ecosystems, DER actively manages over 60 physical restoration projects including dam removal, culvert replacement, and stream day lighting. In 2013 DER leveraged $8.4 million in non-state funds and nearly a quarter million dollars in volunteer assistance. Since its inception DER and partners have removed 22 dams providing hundreds of miles of river continuity and restored over 750 acres of coastal wetlands. DER's annual operating and project budget is $2.0 million. The Division maintains a staff of 15 fulltime equivalents. DER initiates proactive restoration on public and private lands and is not reliant on natural resource mitigation funds. DER draws from multiple funding sources including and public/private partnerships, grants, strategic NGO alliances and natural resource mitigation.

DER provides a template of how to create, tailor and promote a government-sponsored ecological restoration program by merging existing agencies, adapting exiting programs or creating a program from scratch.

To justify investments in restoration DER has conducted systemic evaluations that define economic benefits of ecological restoration in terms of jobs created/sustained as well as the direct, indirect and induced economic benefits of restoration. DER has quantified ecosystem service values of restored vs. degraded ecosystems to spur program and project support. In addition to articulating return-on-investment, DER ties ecological restoration to green-infrastructure, climate change adaption and the growth of a new "restoration economy" to ensure restoration is a core component of Massachusetts state government.

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MONITORING AND AM IN THE MRRP; LESSONS LEARNED AND TRANSITION TO A MORE INTEGRATED PROGRAM

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The Missouri River Recovery Program (MRRP) was established to replace habitat impacted by construction and operation of reservoirs and navigation, bank stabilization and flood control measures on the mainstem of the Missouri River, thus avoiding jeopardy for three federally listed species; pallid sturgeon (*Scaphirhynchus albus*), least terns (*Sternula antillarum*), and piping plovers (*Charadrius melodus).* A Biological Opinion (BiOp) issued by the U.S. Fish and Wildlife Service (USFWS) identified reasonable and prudent alternatives (RPAs) to avoid jeopardy to these Missouri River populations (USFWS 2000, 2003). A key stipulation of the BiOp was the establishment and use of an Adaptive Management (AM) process to address uncertainties associated with the implementation of the MRRP.

An AM process framework was established to identify the products, roles and responsibilities, and timelines for implementing AM strategies formed around two sub-programs; Emergent Sandbar Habitat (ESH) and Shallow Water Habitat (SWH). These sub-programs respectively address the management actions aimed at least tern and piping plover (ESH) and the sturgeon (SWS). Implementation of these programs over a seven-year period (2007 to present) has focused on the development of 1) metrics, monitoring requirements and targets for each objective, 2) conceptual and numerical ecological models for assessing the effectiveness of current and potential management actions in terms of species demographics, and 3) the collection, analysis, synthesis and reporting of data related to program performance.

The AM program is undergoing a transformation from a sub-program focus to a more comprehensive, programmatic effort. The emerging AM program is both objective- and hypothesis-driven, informed lessons from the MRRP and other large-scale AM efforts, and highly coordinated among the AM Integration Team, the agency managers, stakeholders, and an independent science advisory panel. Areas of focus in the transformation include 1) development of a set of robust quantitative models to help predict the effectiveness of management actions, and 2) improvements to the governance structure to better facilitate decision making. Stakeholder coordination has led to the introduction of a suite of “human considerations” that must be factored into decisions. Significant uncertainties regarding the effectiveness of actions aimed at pallid sturgeon recovery will be a near-term AM focus, necessitating the use of active AM strategies and supporting research under the MRR Science Program.

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A PUSH-PULL, INTEGRATED PEST MANAGEMENT SCHEME FOR THE PROTECTION OF BARN OWL NESTS BOXES AND SUGAR CANE WORKERS FROM INVASIVE AFRICANIZED HONEY BEES

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Africanized honey bees (AHB) have steadily invaded the whole of tropical South America since the introduction of 17 bee queens near Sao Paolo Brazil in 1957. By the mid-1990s, Africanized bees became established in the southwestern states of the U.S. and in Florida. Although all honey bees are nonnative in the new world, the African subspecies has presented a specific challenge to beekeepers and endemic wildlife because it is far more aggressive and reproduces at a higher rate resulting in negative consequences. Africanized honey bees reproduce by fission, with swarms of bees moving away from natal colonies to form new hives within cavities. Africanized bees are less selective than European bees when choosing a nest site and often choose locations that can present hazards to humans, such as water meter and electric boxes, pool decks, sheds, wildlife nest boxes and even tractors.

Invasive AHB are threatening a biological rodent control project in the sugar cane fields of Southern Florida. These bees are competing with Barn Owls for their nest boxes, often excluding or killing the owls. In addition, the increasing bee population is putting cane workers in danger. Bee colonies are often agitated by vibrations, the same vibrations that farm equipment causes. This in combination with often unlikely or obscured nesting sites, for example, culverts, puts unaware cane workers at risk of attack.

We have developed a push-pull integrated pest management protocol to deter bees from inhabiting owl boxes by applying a bird safe insecticide, permethrin, while simultaneously attracting them to pheromone-baited swarm traps. These swarm traps are highly visible and located eight feet off the ground thereby reducing conflict with sugar cane workers. These bee traps are monitored weekly and swarms are removed. The use of highly visible bee traps located off the ground will reduce the likelihood of workers being attached by defensive bee colonies and could ultimately save lives. This study also serves as a model for developing a field protocol for use in the Neotropics were many endangered cavity-nesting birds are adversely affected by AHB.

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RESTORATION OF COASTAL HABITATS IN MISSISSIPPI THROUGH THE PROGRAMATTIC BENEFICIAL REUSE OF DREDGED MATERIALS

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Mississippi is implementing significant coastal restoration through its growing program to recycle materials that are routinely dredged but have traditionally been discarded. The Mississippi Beneficial Use Program (MSBU) which reformed after Katrina in 2008 has been supported by growing participation in its monthly Beneficial Use Group (BUG) meetings. Co-chaired by the Mississippi Department of Marine Resources and the USACE Mobile District (Corps), the BUG keeps a broad range of government and private entities engaged in the creative process of matching ecological priorities with dredged resources in ways that are economically tenable. Particularly through its Steering and Technical subcommittees, the BUG has served as a focal mechanism for the development of new laws, policies and techniques that add impetus, administrative consistency and innovation to this growing program.

This collaborative mechanism has produced Mississippi's first significant non-federally sponsored BU / ecological restoration and creation projects. In 2012, Mississippi State Port Authority at Gulfport (MSPA) implemented a facility expansion that generated over 300,000 cubic yards of dredged material. To accommodate this material, MSPA paid for the construction of a new 40 acre marsh cell and restored an existing 50 acre Corps project at Deer Island. The MSPA saved money both in direct costs and because barging the material to Deer Island saved time and led to earlier project completion.

A similar project came to fruition in 2013. V.T.Halter Marine (Halter) along with the Port of Pascagoula began a 70 acre marsh, beach and Chenier habitat restoration project on the north shoal of Round Island. An expansion of dockside facilities at Halter would generate about 350,000 cubic yards of "new cut" material perfect for creating a resilient island restoration. This project consists of an initial "toe" dike created by dredging and sidecasting sand from the shoal to create initial containment perimeter. Material pumped in from the Halter expansion then reinforces the toe dike and brings elevations across the interior of the site up to levels that can support marsh development.

Keeping Mississippi's ecological systems in balance is going to require more aggressive restoration. The state has lost approximately 10,000 acres of tidal marsh since the 1950s and has suffered a corresponding decline in fisheries productivity. Mississippi's annual 200 acre marsh loss can be readily reversed if the current average volumes of private and federal dredged materials are fully redirected toward restoration. A key to that utilization is the development of pre-permitted BU projects which can accommodate dredged materials from various sources over a number of years instead of building separate projects for each source. Following this trajectory, the next steps for the MS-BU will be initial assessments for projects that may extend upwards of 1000 acres.

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CONTINUOUS, REAL-TIME NUTRIENT DATA AND REGRESSION MODELS – VALUABLE INFORMATION FOR MONITORING AQUATIC ECOSYSTEM RESTORATION

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In-stream monitors and continuous, real-time data have become an increasingly important component of programs designed to evaluate water quality and ecosystem health. Continuous, real-time water-quality data are used in research and in municipal, industrial, state, and federal monitoring programs to understand aquatic ecosystem processes and factors that affect them, to document changing conditions, and to make comparisons to regulatory criteria. However, these data are less common in applications related to aquatic ecosystem restoration. Many studies have shown that continuous water-quality data measure variability that often is missed with conventional sampling methods. Data displayed in real-time on the Internet are readily available to all interested persons, providing information on current conditions and enabling subsequent implementation of adaptive sampling and management strategies.

Continuous, real-time data may not be commonly used in restoration efforts in part because of limitations in available sensor technologies for directly measuring water-quality characteristics and ecosystem processes of particular interest, such as nutrient concentrations and stream metabolism. Nutrient enrichment is a leading cause of degradation in rivers, streams, lakes, reservoirs, wetlands, and estuaries. Use of continuous nutrient data may lead to improved understanding of nutrient dynamics and ecosystem processes affected by restoration efforts. In-stream nutrient monitoring technologies have improved with the availability of nitrate sensors. In addition, sensor limitations may be overcome by the use of regression models for water-quality constituents of interest, such as nitrogen and phosphorus species, that are developed from continuous and discrete water-quality data. Stream metabolism can be calculated using commonly measured continuous data to assess changes in ecosystem function. Examples of continuous, real-time monitoring approaches, practical applications, and effective data display demonstrate the value of this information in understanding ecosystem processes and responses to restoration projects.

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NOVEL ECOSYSTEM MANAGEMENT STRATEGIES IN BORNEO

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All of the world's ecosystems are affected by some form of environmental change, with an overwhelming majority of this change stemming directly from human dominance and mismanagement. Such pressures often result in transitions to novel ecosystem states that are less resilient, less stable, and produce fewer ecosystem services than previous counterparts. Tropical forests are not immune to this, as a majority of land in the tropics has a history of anthropogenic influence, often in rural and subsistence contexts. Such contexts often require resources beyond direct production areas, extending their impact. As a result, less than half of primary tropical forests remain, and significant areas of degraded lands are in need of conservation and restoration. This is cause for concern because tropical forests contain over 50% of the world's biodiversity, store over 40% of the world's terrestrial carbon, and constitute over 60% of the world's conservation priority hotspots. Yet conservation is often perceived as counterproductive in many tropical regions, especially if the costs of establishing preserves are borne by local peoples. Further, current and future restoration goals must recognize that most ecosystems are dynamic and include local human populations, requiring management that can adapt to changing conditions. In many circumstances, the ideal structure of a managed production system should resemble native ecosystems and their services, with tropical production systems resembling forests that equate to novel tropical forest ecosystems. Thus, the concept of 'novel ecosystems' is an appropriate perspective, as it contextualizes the effects of human influence on ecosystems, while 'ecosystems services' is an appropriate rubric, as it encapsulates the complexities of human-environmental interdependence in ecosystems.

The main goal of this research is to assess physical measures, local views, and agency stances on best management practices in high-sensitivity, high-biodiversity rainforest ecosystems, and how these affect biodiversity, carbon storage, food and livelihood production, and sustainability via embodied energy analysis for various ecosystem management strategies. This research focuses on regions that were historically lowland rainforest ecosystems in Sarawak, Borneo. Indigenous, subsistence, and cash crop farmers were interviewed as well as foresters and park rangers from government-based conservation, restoration, and plantation forestry contexts. Study locations include Kubah National Park, Gunung Gading National Park, and the indigenous Iban longhouse settlement of Rumah Siba Perdu. Preliminary findings indicate that both government-based conservation and restoration forestry and related land management practices differ significantly from those present in traditional or subsistence contexts, presenting a basis for comparison and analysis as well as an opportunity for developing potential new management strategies that meet the needs of concerned interests, with anticipated results indicating favorable options.

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RESTORATION REQUIRES RETROSPECTION: PALEOECOLOGICAL APPLICATIONS SUPPORT MANAGEMENT OF THE LAURENTIAN GREAT LAKES

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The USEPA is in its 31st year of comprehensive monitoring of the Great Lakes. Recent algal monitoring data have revealed significant changes in whole-lake conditions, particularly within the last decade. In most cases trends indicate a drop in algal abundance resulting from the effects of invasive species and changing water quality. Lake Erie is an exception, where pelagic algal abundance is on the rise. Not surprisingly, those responsible for tracking and maintaining ecosystem services on the Great Lakes are concerned about the ecological trajectories of the lakes.

Contemporary monitoring alone is not always sufficient to answer important management questions, so we are employing paleolimnology to put modern conditions in a long-term context. Paleolimnology uses lake sediment components to infer past conditions and to uncover trends in environmental quality. These retrospective data are needed to distinguish natural from human trends, and to reveal the causes and magnitudes of environmental insults that inform management matters regarding climate change, pollution and invasive species. The cornerstone of many previous paleolimnological investigations has been the use of diatoms, known powerful indicators of environmental change. The diatom algae from the Great Lakes have been calibrated to nutrients, and a diatom-based phosphorus model was used in a paleolimnological investigation of Lake Superior to reconstruct its trophic history. Changes in climate are also affecting the physical properties of Superior, which is in turn causing a shift in species composition. Investigations are continuing to describe the anthropogenic history of degradation and remediation in all of the lakes. It is anticipated that algal indicators and paleoecological applications will serve to address the many environmental issues that require long-term data in order to make remedial decisions.

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SUSTAINABLE SOURCE WATER PROTECTION – AN ACTION PLAN FOR BIG CREEK LAKE

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Sustainable, long term preservation of source water quality for potable water reservoirs poses a unique set of challenges. To ensure the sustainability of the water quality in Big Creek Lake, a potable water reservoir for the Mobile metro area, we developed an actionable watershed management plan for the lake's watershed. Major management challenges are the sub-urbanization and urbanization of this rural watershed and resulting pollution loads, as well as in-lake nutrient and carbon dynamics. There are few regulatory or land use tools available in the area to address the source water quality issues caused by increasing development in the watershed or the types of pollution sources that currently exist.

To determine how existing watershed management affects water quality we implemented a stepwise approach to studying the problem and developing solutions. We first updated the previous characterizations of the 100 sq. mi. watershed, then collected hydrologic and water chemistry data to verify current conditions, including nearly 200 miles of stream walks. We reviewed the applicable land management and development regulatory schemes, land management practices and existing land uses in the watershed. We assessed the presence of exotic species and land management practices on the water authority's lands. In addition, working with local partners we developed a potential future land use map of the watershed. From this body of information we developed hydrologic, nutrient and carbon budgets for the lake and modeled future conditions based on the future land use map developed for the project. The model results were then used to determine where the potential water quality constraints were in the current condition and likely to be in the future condition.

The next step in the process was to identify actions that protect or restore areas with potential future source water quality issues. A series of criteria were developed to proactively choose locations for restoration and ecosystem buffer projects based on the management objectives. The lack of regulatory tools in the watershed mean that non-regulatory and incentive-based approaches must be relied on to ensure source water protection. Planning constraints and solutions will be addressed, including the lack of ecological and natural resources GIS data for the study area which added a level of complexity to the planning process. The goals related to each type of management objective and the criteria developed to address them will be highlighted. The approach, criteria and examples will be addressed in the presentation.

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STRIVING FOR SYSTEM CHANGE: SETTING OBJECTIVES AND MEASURING RESPONSE

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The call for large scale ecosystem restoration efforts to be science-based in common and many programs have made great strides in using available knowledge to inform plans as they are developed. Most people recognize the numerous uncertainties can affect the management of a large ecosystem, e.g., environmental variability, imperfect knowledge of the system or resource state, and a lack of understanding of the biological and ecological relationships. In addition, complex social-ecological dynamics challenge how investments decisions for ecosystem restoration are made. There is often an expectation of certainty and 'guaranteed' outcomes prior to the commitment of financial resources. These are inherent difficulties for managers tasked to restore ecosystems and protect communities with incomplete knowledge of how the system works, or how management actions may impact the system and those that rely on it. This presentation will discuss the interface among those that fund programs, those tasked with managing large ecosystems, and scientists who strive to understand system dynamics.

A key early step in ecosystem restoration is agreement on the programmatic objectives. In coastal Louisiana expectations of ecosystem restoration outcomes may have been unrealistic for almost two decades, as programs touted very generalized objectives, such as 'improved fish and wildlife habitat'. Louisiana however, at least had the advantage of a clearly recognizable 'problem' with massive coastal land loss. In Puget Sound, in contrast, even though individual shoreline restoration projects could demonstrate a positive change in local ecosystem outcomes, the overall 'problem' that a century or more of shoreline modification has produced has been difficult to communicate. In the development of the restoration program for 15,000 acres of salt ponds in southern San Francisco Bay, planners had to deal with the fact that the loss of tidal marshes had actually resulted in valuable salt pond habitat for some important species. A parallel path forward was then adopted which enables the objective 'end-state' to be adjusted as restoration proceeds. Further challenges can arise when large-scale ecosystem restoration is one of several goals combined under a single program. This is the case in Florida where the Central Everglades Restoration Program seeks to provide water supply to urban areas as well as ecosystem restoration outcomes, and in the California Bay-Delta where several system-scale initiatives have now adopted 'co-equal' goals of water supply and ecosystem restoration.

In all of these cases, the application of scientific information to understand what is achievable, with certain levels of funding, time and other resources, as well as what it takes to get to a 'desired' end state is crucial. The mismatch among which ecosystem restoration outcomes are needed (e.g., to enable other activities to proceed in a regulatory framework that considers the ecosystem important), which are desired (and by whom) and which are achievable given resource and other constraints, is rarely recognized. Science has a key role in identifying what is possible and tracking in the long-term whether it is achieved.

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PANEL: EARTH WITHOUT "ART" IS JUST EH

***Nanciann Regalado*[1]*, Stu Appelbaum*[2]*, Gwen Eyeington*[3] *and Lucy M. F. Keshavarz*[4]**

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Art can play an important role in communicating, advocating and building knowledge and support for ecosystem restoration efforts. Elements of art also can be used in creating environmental restoration projects. Unfortunately, art has remained a largely underutilized tool for connecting individuals and communities to environmental restoration issues and efforts. More often than not, artists have perspectives and understandings that are different from engineers and scientists, and they can help frame implementation issues in ways that resonate with new audiences. Aviva Rahmaini has defined four benefits of incorporating artists to our ecosystem restoration interdisciplinary teams:

Artists can help build a driving narrative for community and the media.
Artists are wild cards, often catching ideas ahead of science and being educative catalysts.
Ecological artists can help build broad cultural constituencies.
Ecological artist can initiate novel strategies to create a set of values.

This interactive panel will explore the role of art in communicating about and designing restoration. Everglades restoration will be used to demonstrate the struggles of implementing a large multi-decade restoration program. The challenges of implementing the large Everglades public outreach program, with both its passionate stakeholders and interest groups and diverse regional population will also be presented. Previous work by artists to connect people to ecosystem restoration and to create projects will be described. The audience will be encouraged to engage in a discussion about ideas and opportunities for using art. This discussion will encourage conference participants to think beyond their current approach to outreach, advocacy and design.

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RESTORING THE MISSISSIPPI RIVER DELTA: LESSONS LEARNED FROM LEGACY STRUCTURES

Alisha A. Renfro
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The modern-day Mississippi River Delta was formed over the last 7,000 years as the river and its distributaries migrated across the deltaic plain, delivering sediments derived from the river's large drainage basin. Since the 1930's coastal Louisiana has lost nearly 5,000 km^2 of ecological and economically vital coastal habitat. Several factors have contributed directly or indirectly to this land loss. One of the most significant drivers is the straitjacketing of the lower Mississippi River by flood protection and navigation levees following the devastating flood of 1927. While these levees have helped protect communities and sustain waterborne commerce, they have essentially halted the processes that once built and maintained the economically and ecologically important wetlands of the Mississippi River Delta.

Projections of the future landscape of Louisiana without large-scale restoration depict a bleak future. Sediment diversion projects that mimic the natural process that once built and maintained the wetlands of the delta are an essential component for creating a more sustainable future for coastal Louisiana. As planned sediment diversions move into design and implementation, lessons learned from legacy structures, such as the freshwater diversions at Caernarvon and Davis Pond, the uncontrolled sediment diversion at West Bay, the Bonnet Carré and Bohemia spillways, and the Wax Lake outlet provide important information about the location, design and operation of sediment diversions that would maximize sediment capture and enhance land-building.

While no perfect analog for the planned sediment diversions currently exists, combining the information from these different legacy structures can help resolve some of the questions and concerns that currently exist. Restoration of the Mississippi River Delta's wetlands will depend on using a variety of different types of restoration tools. While all of these tools are important, only sediment diversions mimic the natural processes that once built and maintained the delta and address the scale of land loss that has been observed. Without bold and large-scale action, the catastrophic rate of land loss will continue, leaving the communities, infrastructure, and wildlife more vulnerable every year.

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AMERICA'S WATERSHED INITIATIVE - ENGAGING DIVERSE STAKEHOLDERS IN A COLLABORATIVE, INTEGRATED MANAGEMENT APPROACH TO AMERICA'S (MISSISSIPPI) WATERSHED

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America's Watershed Initiative is working to bring a collaborative, basin-wide perspective to the Mississippi River Watershed's greatest management challenges while also supporting the many initiatives and work at smaller scales. More than half the goods and services consumed by the citizens of the United States are produced with water that flows through the Mississippi River and its major tributaries – the Ohio, Missouri, Arkansas and Red Rivers. Agricultural products from the Mississippi River Basin are worth $54 billion annually and represent 92 percent of the nation's farm exports. The Mighty Mississippi serves as a vital conduit for goods, is home to the largest port complex in the U.S., protects and sustains vital coastal landscapes and gives life to the Gulf of Mexico's vibrant seafood industry. Our rivers make possible commercial fishing and outdoor recreation that generate billions of dollars each year. Undoubtedly, the health of our nation's economy and people are directly tied to the decisions we make in managing the Mississippi River and its tributaries.

Leaders in the watershed recognize that geographic, institutional and issue-based silos have become barriers to achieving the economic, social and ecological potential of this vital watershed. Global opportunities will pass us by and costs will increase if we let state borders –or smaller boundaries – divide this interconnected river system. We will fail to realize the long-term potential of the broader watershed if we address issues independently—if, for instance, we address water quality separately from water quantity, or land management separately from water management.

America's Watershed Initiative seeks to build and implement a shared vision based on collaboration and mutually beneficial outcomes in contrast to single-purpose advocacy. We are working to find solutions to issues that span multiple regions—issues such as energy, transportation, water quality and more comprehensive flood management—while respecting and utilizing vital constituencies and programs that functions at specific sub-basin scales.

The Initiative envisions a Mississippi River Watershed that:

Supports local, state and national economies
Supplies abundant, clean water to farms and communities
Nurtures healthy, productive ecosystems and the habitats upon which they depend
Serve as the nation's most valuable river transportation corridor
Provides reliable flood control and risk reduction
Creates world-class recreational opportunities

America's Watershed Initiative is working with stakeholders from businesses, citizens organizations, Federal, state and local agencies and the research community to develop a comprehensive report card to summarize and communicate the status and trends in achieving agreed upon objectives for the six broad management goals stated above. Working with partners in each of the six river basins, we are convening workshops with experts to identify key measurements for that basin. The results from the basins will be integrated into a report card for the entire Mississippi River watershed which will be presented for feedback at the next America's Watershed Initiative Summit, to be held on October 1-2, 2014 in Louisville, KY. (americaswatershed.org)

The Report card is one key action to develop a shared vision for the watershed and will be a tool to encourage more cooperative action and supporting more integrated management of the land and water resources in the watershed.

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WHAT IS AN APPRORIATE REFERENCE FRAMEWORK FOR ECOLOGICAL ASSESSMENT, RESTORATION, AND MONITORING?

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An appropriate reference framework depends ultimately on how the framework will be used. Once that is established, a framework can be customized to suit the application, from simple to complex. However, before building a reference framework for an ecosystem, one must first thoroughly understand how the ecosystem is structured, its major functions, the major biotic and abiotic factors that normally influence ecological condition, and typical human-caused stresses. Specifically, a framework would benefit by taking into consideration as much of the following information as possible: (1) the range of conditions typically encountered for the ecosystem, from good (best attainable condition) to poor (minimal functioning condition), (2) environmental stresses that typically prevent the ecosystem from reaching its best attainable state, (3) constraints that might inhibit complete or partial restoration, how the constraints interrelate, and what impediments and opportunities they provide for formulating a restoration plan, (4) potential self-sustaining, reasonably-attainable, target conditions to which an ecosystem can be restored, and (5) potential intermediate target conditions that could be useful for gauging whether an ecosystem is on an appropriate trajectory to the best attainable condition. These five categories of information provide most of the essential information needed to construct a robust reference framework for most purposes, for example, to evaluate the condition of an ecosystem, track recovery through time, and gauge the success of restoration efforts.

The construction of three example reference frameworks will be discussed, with each framework customized for either assessment, restoration, or monitoring, and with all incorporating the important elements mentioned above as being useful for guiding the construction of a framework. The simplest application discusses the restoration of a *Distichlis/Salicornia* high marsh that was eroding and dying back in response to human trampling. A more complex application discusses the development of a reference framework for the rapid assessment of headwater stream/floodplain ecosystems in rural, agricultural landscapes, developed to plan stream network restoration in impaired, coastal watersheds. The third example uses quantitative vegetation data to test the applicability of using multivariate ordinations to determine if tree species compositions of forested wetland restoration sites are on a successful trajectory toward the target ecosystem, i.e., mature, un-drained, wet hardwood forest of mineral soil flats. Although the three applications vary in complexity and purpose (for restoration, assessment, or monitoring), they all demonstrate how important it is to use variations in the condition of real ecosystems, due to both natural and human-causes, in a frame of reference.

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REBUILDING CORAL REEFS THROUGH THE GARDENING CONCEPT: ACTIVE REEF RESTORATION MAY LEAD TO SUSTAINABLE REEFS

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The coral reefs worldwide are exposed to multiple anthropogenic threats and persisting global change impacts, causing continuous degradation, in spite of the intense conservation efforts that are globally imposed. This calls for the development of novel rehabilitation approaches that include restoration methodologies. Of the most promising emerging approaches, deriving its rationale from silviculture, is the low-cost "*gardening concept*", *guided by a two-step restoration operation: (a) mid-water nursery phase, where coral-nubbins are farmed, (b) transplantation of nursery-farmed colonies.* Tested worldwide, at least 86 coral-species and over 100,000 colonies were successfully farmed in different archetype nurseries, and several novel transplantation methodologies were developed. Furthermore, the gardening notion has surmounted four major obstructions, all are satisfactory deciphered: (a) developing the needed credentials for farming a wide variety of coral species in mid-water nursery; (b) the ability to develop stocks of coral colonies, employing the 'nubbins' methodology *(c) documentation that nursery farmed coral colonies perform well in their 'new homes', following transplantation*; and (d) verification of the low cost gardening approach. In addition to the expected results, a number of unanticipated outcomes emerged. These include the immediate establishment of coral infaunal biodiversity within the nurseries, the development of nurseries into 'larval dispersion hubs' and the enhanced reproduction of transplanted coral colonies. Altogether, and in addition to envisaged results (e.g., high survivorship, fast coral growth), the outcomes attest that the gardening-toolbox could be served as a ubiquitous ecological engineering platform for restoration on a global scale. An overview on the last two decades' work on active reef restoration through the gardening tenet will detail results from various reef sites worldwide, dealing with the nursery and transplantation phases of reef restoration.

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BARATARIA-TERREBONNE NATIONAL ESTUARY PROGRAM—CLEANING UP OUR WATERWAYS

Alma Robichaux *and Kerry M. St Pé*
Barataria-Terrebonne National Estuary Program, Thibodaux, LA, USA

Established in 1991, the mission of the Barataria-Terrebonne National Estuary Program (BTNEP) is the preservation and restoration of the Barataria-Terrebonne estuarine system, the 4.2 million acre region between the Atchafalaya and Mississippi Rivers. The BTNEP, one of 28 National Estuaries, strives to rebuild and protect the estuary for future generations through the implementation of a science-based, consensus-driven plan that utilizes partnerships focused on the estuary's rich cultural, economic, and natural resources.

The Nature-Based Tourism and Recreation Action Plan in our Comprehensive, Conservation and Management Plan (CCMP) calls for the promotion of education and clean-up programs to address litter and marine debris along our highways and in our waterways. Plastics and other trash are entering our environment at an alarming rate and end up in our oceans, waterways, lakes, marshes, beaches, etc. There is no place you can go without seeing a plastic drink bottle or container. The Barataria-Terrebonne National Estuary Program (BTNEP) has launched several awareness programs to help eliminate this problem.

For the past 3 years, BTNEP has held an annual Bayou Lafourche Cleanup to raise awareness of marine debris. Bayou Lafourche bisects our national estuary and is a distributary of the Mississippi River. It provides drinking water for 300,000 residents and is a source of water for several industrial facilities. The cleanup involves thousands of volunteers and covers 106 miles of Bayou Lafourche. The past 2 years have proven successful in removing 35 tons of trash from the bayou including 53,007 plastic bottles, plastic bags, and other plastic containers. Results are recorded and sources are identified.
To combat plastics entering the environment, BTNEP is supplying shoppers with reusable shopping bags made from recycled plastic bottles material. BTNEP hopes to use this program as a pilot program for the state to reduce or eliminate plastic shopping bags.

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THE EVOLUTION OF GOVERNANCE: INSTITUTIONAL TRAJECTORIES & LARGE-SCALE ECOSYSTEM RESTORATION

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The past several decades have seen the development of several large-scale ecosystem restoration efforts throughout the United States – California Bay-Delta, Chesapeake Bay, Columbia River, Everglades, Great Lakes, Platte River, and now the Gulf Coast. Many of the contemporary versions of these efforts are funded through federal-state partnerships, and the initiation of these partnerships often comes with the creation of a governing institution, whether newly formed or collaborative.

The development and evolution of Gulf Coast ecosystem restoration institutions are unique for two reasons in particular. Typically, there is a gradual accumulation of scientific evidence regarding environmental degradation and slow growth of public and political support for ecosystem restoration. For the Gulf Coast, a catastrophic event – the Deepwater Horizon Oil Spill – was the impetus, serving as both the cause and means of funding, for restoration. Moreover, while this regional-level effort may be nascent and singular in origin, embedded within it are some well-established plans and institutional structures with complex histories at the state-level.

This research will begin by reviewing the development and evolution of various large-scale ecosystem management institutions, providing a comparative foundation on which to base analysis and discussion of the Gulf Coast ecosystem restoration institutional trajectories, including the concepts of temporal scale, key drivers of support and change, and institutional imitation and translation. The relationships among well-established, state-level institutions and the newly established, regional-level institutions will provide a rich layer of analysis, identifying points of tension and cohesion among these nested institutional trajectories.

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RESTORING AMERICA'S GREATEST RIVER: COLLABORATIVE EFFORTS ALONG THE LOWER MISSISSIPPI

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The Lower Mississippi River flows unimpounded from its confluence with the Ohio River to the Head of Passes in Louisiana. This 954-mile section of river winds down a gently sloping valley and divides into several distributaries carrying water to the Gulf of Mexico. The Lower Mississippi River and its floodplain have been significantly altered to provide infrastructure for navigation and flood risk management. However, it remains a dynamic and functional ecosystem that is constantly being improved by unique partnerships in the region.

Historically, the alluvial valley of the Lower Mississippi River was over 20 million acres of bottomland hardwood forests with meandering streams and bayous, forming floodplain lakes. The construction of the Mississippi River levee system reduced the floodplain by over 80% and allowed for land clearing and development of the valley as a rich agricultural area. Over the past 30 years, there has been a gradual but significant loss of secondary channels and their associated habitats in the Lower Mississippi River due to channel engineering.

There are three endangered species in the Lower Mississippi River: pallid sturgeon, Interior least tern and fat pocketbook mussel. These species occupy similar habitats as the numerous fish, aquatic invertebrates and migratory birds that depend upon in-channel habitat, secondary channels and seasonally flooded shallow water habitats. The U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, Lower Mississippi River Conservation Committee and other partners began conducting annual meetings in the 1990s to identify and incorporate environmental features into routine maintenance and construction activities to reduce impacts to trust resources. Additional projects constructed in recent years include weirs to prevent dewatering of floodplain oxbow lakes and restoration of flow in more than 53 miles of secondary channel habitat.

The efforts of this partnership have led to several unprecedented initiatives for the Lower Mississippi River. The U.S. Army Corps of Engineers recently completed a Conservation Plan for the three endangered species that outlines conservation measures through the Channel Improvement Program, to which the U.S. Fish and Wildlife Service issued a non-jeopardy biological opinion. Additionally, partners in the region are collaborating on the Congressionally-authorized Lower Mississippi River Resource Assessment which provides a framework for identification and completion of additional habitat restoration needs.

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RESTORING THE AMERICAN CHESTNUT: OPTIMIZING FOUNDER SPACING TO PROMOTE POPULATION GROWTH AND GENETIC DIVERSITY RETENTION

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Efforts are underway to restore the American chestnut (*Castanea dentata*) to the forests of eastern North America following its decimation due to the introduction of the chestnut blight (*Cryphonectria parasitica*). Approaches include the development of blight-resistant chestnut lines through backcross breeding programs and via genetic engineering. Successful development and re-establishment of resistant chestnut throughout eastern forests will produce one of the most extensive ecological restoration transformations ever attempted. However, this undertaking is costly and optimization of reintroduction methodologies is needed. Here we use the computer program NEWGARDEN to model whether some patterns of placement of founders (regular versus random spacing at differing densities) produce more rapidly expanding populations than others across a wide range of gene dispersal distance conditions (via both offspring and pollen). We found that for an introduction project employing 169 founders under the conditions used here, placing the founders randomly in a square of side 0.66 km will produce higher rates of population growth compared to larger or smaller squares under near gene dispersal conditions; this side distance is 2.2 km under far gene dispersal conditions. For example, under 'near' gene dispersal conditions, the trial with founder placement producing the greatest population expansion, growth was 492% greater than the slowest growing population with a lower density of founders. Neither loss of alleles, nor inbreeding or subdivision as indicated by F_{it} values, were significantly increased under the "optimal" founding patterns. Exploring different numerical and geometrical founding scenarios using NEWGARDEN can provide first estimates of founding patterns or post-establishment stand manipulations that will return the most descendants produced over generations per founder planted in restoration projects.

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A BIOLOGICAL DATA VIEWER FOR FLORIDA'S EVERGLADES: THE NEED FOR REAL-TIME DATA FOR INFORMED DECISION MAKING

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Florida's Greater Everglades is a biologically diverse wetland ecosystem. Restoring this landscape to its more natural state, before human interference, is a challenging process and requires a comprehensive understanding of the ecological and physical processes at work in the ecosystem. Scientists throughout the nation have been studying many aspects of the Greater Everglades ecosystem over a period of decades. Biological monitoring includes endangered species such as the Wood Stork, invasive species such as the Burmese Python, and iconic species such as the American Alligator. The Joint Ecosystem Modeling (JEM) group was tasked with the development of a spatial data viewer to provide public access to data collected in and around the Everglades. The JEM Biological Data Viewer (JEM BDV) enables researchers to better communicate the magnitude of their findings to decision makers, land managers, other scientists, and the general public. The JEM BDV also offers a number of features for researchers and agencies to protect sensitive information (e.g., the exact location of individuals of a critically endangered species) by temporally and/or spatially obscuring such information. The obscured data displayed publicly is informative and may be in the form of daily or yearly average locations or occupancy regions (appearing as polygons) rather than exact locations for each data point (appearing as dots). As data are entered into the databases for various research projects, the potential exists to provide real-time alerts for important biological events. For example, email alerts can be sent to partner agencies when species of interest are detected within the boundaries of lands they manage, or sent when animals spend an extended period in one location which could indicate initiation of breeding. The development of the JEM BDV is the first step toward amassing the wealth of biological data collected in the Everglades. Future steps could include incorporating landscape scale environmental data (e.g., land cover, hydrology) to help explain biological occurrences.

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CAPTURING A HOLISTIC UNDERSTANDING OF A LARGE MARINE ECOSYSTEM - NOAA'S GULF OF MEXICO DATA ATLAS

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As plans to restore the Gulf of Mexico after recent disasters have progressed, federal and state agencies have turned to NOAA for data and information about all aspects of the Gulf of Mexico. One of the most requested resources for that data and information has been the "Gulf of Mexico Coastal and Ocean Zones Strategic Assessment Data Atlas" published by NOAA's National Ocean Service in 1985 as a large hardcopy tabletop book. The new Gulf of Mexico Data Atlas provides access to these and similar data in digital form for easy discovery and ready access.

NOAA's National Coastal Data Development Center brought together data providers from international, federal, state, and non-governmental organizations. A multi-agency executive steering committee was formed to guide Atlas development and to contribute data and expertise. NCDDC developed the Atlas as a web-based tool that allows users to browse data as digital map plates organized by subject matter themes. Its geographic scope encompasses Gulf of Mexico coastal counties of the USA, as well as Mexican municipal districts bordering on Gulf of Mexico waters. The seaward boundaries extend to the Yucatan Channel and the Straits of Florida.

The Atlas currently contains over 230 maps in 70 subject areas. The Atlas website uses ArcGIS Server to generate tiled map plates that are consumed and displayed quickly in the web browser to enhance users' experience. ArcGIS Server also exports the map data as web mapping services (WMS), Representational State Transfer (REST) API, and KML for use in other web-based platforms and desktop applications. Each data set is fully documented by metadata in both Federal Geographic Data Committee CGDSM and ISO schemas. Links back to the source data, available in native formats, enable researchers to perform their own analyses. Datasets are also searchable through an accompanying Map Catalog and RSS feed.

A diverse group of users have found the Gulf of Mexico Data Atlas to be an easy entry point to data from a wide range of inter-disciplinary sources. NCDDC continues to update and add datasets through new and existing partnerships to ensure that the Atlas becomes a truly ecosystem-wide resource. As a member of the International Coastal Atlas Network (ICAN), NCDDC is committed to sharing the technology, methods, and expertise gained during the development of this resource with others working on similar efforts. The Gulf of Mexico Data Atlas is an operational example of the philosophy of leveraging resources among agencies and activities involved in geospatial data as outlined in the US Department of Interior and FGDC's "Geospatial Platform Modernization Roadmap v4 - March 2011".

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MODELING THE EFFECTS OF DIVERSIONS: CAN THE BIOLOGY AND DATA KEEP UP WITH COMPUTERS?

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River diversions are a major, but controversial, management approach to restoring coastal wetlands and mitigating offshore oil spills in the northern Gulf of Mexico. One of the controversies concerns potential spatial displacement and resulting salinity stress to commercially and recreationally important fish species. Our ability to develop, test, and apply models to assess the effects of large-scale diversions is presently limited by our knowledge of the biology and the availability of certain data. In the past, models were constrained by computing resources; however, this constraint is no longer valid in many cases due to the rapid advances in computing power. We use three examples to illustrate the current state of modeling for assessing diversion effects and some future directions.

The first example is a high resolution coupled hydrology-hydrodynamics model applied to the Barataria Estuary and used to simulate salinity changes from releases from the Davis Pond diversion (Das et al., 2012). The spatial and temporal patterns of the resulting salinity were complex, and demonstrated high small-scale variability in salinity that could only be captured with a high-resolution model. The second example used the output of the Finite Volume Coastal Ocean Model (FVCOM) to simulate fish behavioral movement responses as salinity changed during a diversion release (Rose et al. 2014). Simulation of thousands of individual fish under previously observed releases showed that fish found preferred salinities by moving 15 to 35 km down estuary, but in some cases, were exposed to sub-optimal salinities for extended time periods. The third example examined food web responses (33 functional groups) to a proposed diversion using a common food web modeling approach (CASM) applied to Barataria Estuary (Dynamic Solutions 2013). One year simulations with pulsed salinities showed both direct and indirect responses of key consumers that varied in magnitude within the estuary.

Data to refine these types of simulations are rapidly becoming available as measurement technologies advance. What is needed is the combination of these new measurement technologies with traditional detailed monitoring. These field studies must be specifically designed to answer the questions related to diversions effects and in coordination with the modeling. Such coordinated efforts can then provide the sound basis for an adaptive management approach for increasing the economic efficiency and ecological effectiveness of diversions.

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IMPLEMENTING A LANDSCAPE-LEVEL OAK HABITAT RESTORATION INITIATIVE WITH LOCAL WORKFORCE PARTNERSHIPS

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Less than 1% of Oregon white oak-dominated habitats are protected in perpetuity as oak habitat has disappeared from over 90% of Oregon. Private lands hold the key to restore and conserve this crucial wildlife habitat. Oak habitats provide life history resources to over 200 species of wildlife, including several listed species. We are in the third year of implementing a 2000 acre habitat restoration project by removing encroaching conifers from Oregon white oak stands, applying prescribed fire in prioritized sites, treating invasive species and enhancing the native grass understory. The establishment of strong partnerships leverages funding, provides additional technical expertise, leverages completion of environmental compliance, the sum of which provides better on the ground results. A strong avian and plant community monitoring component on every treatment site is also a solid core of this innovative project. The creation of several local workforce initiatives, including with The Klamath Tribe, have been essential to the long-term success of this landscape initiative. This collaborative restoration project, conducted entirely on private ownerships, has provided a template now used by government agencies. This innovative effort has led to other oak restoration initiatives, creation of local oak working groups, and strengthened an employment-based restoration workforce.

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CWPPRA: PROGRAMMATIC LESSONS LEARNED FROM 23 YEARS OF COASTAL RESTORATION

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The Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) has been the primary funding mechanism for coastal restoration in Louisiana since 1990. Passed by Congress in 1990 to address Louisiana's coastal wetland loss crisis, CWPPRA is funded via the Sport Fish Restoration and Boating Safety Trust Fund (Trust Fund) and is supported by excise taxes on fishing equipment and small engine and motorboat fuel taxes. CWPPRA provides approximately $80M to $90M a year in federal funding for planning, design, construction, maintenance, and monitoring of coastal restoration projects. CWPPRA is administered by a multi-agency task force which includes the Department of Army (Corps of Engineers), Department of Interior (Fish and Wildlife Service), Department of Commerce (National Marine Fisheries Service), Department of Agriculture (Natural Resources Conservation Service), Environmental Protection Agency, and the State of Louisiana. In addition to agency involvement, the program allows for a high degree of public input in its annual project planning, evaluation, and funding process. Total CWPPRA funding has topped $1.4B with 151 active projects which will restore/protect nearly 105,000 acres.

Spanning 23 years, the CWPPRA program has undergone its share of challenges and new directions and offers an interesting array of lessons learned including: 1) Now operating under the third plan developed to guide coastal restoration efforts in Louisiana – Louisiana's Comprehensive Master Plan for a Sustainable Coast – the program has had to adjust and adapt to new guidelines and restoration objectives; 2) Serving as a project incubator for other restoration efforts, this unforeseen benefit of the program has provided a broad base of restoration expertise as well as shovel-ready projects; 3) Program flexibility and adaptive management have allowed the program to adjust to socio-economic concerns, storm impacts, and allowed the program to take advantage of restoration opportunities; and 4) Planning for project life beyond the 20-year authorized lifespan may be the next challenge for the CWPPRA program.

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THE OIL SANDS OF ALBERTA (CANADA); RECLAIMING MARSH VEGETATION AFTER MINING

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The post-mined conditions existing in the oil sands region of Alberta, Canada offer numerous reclamation challenges. Over the past 60 years, mining has had a large impact on the regional landscape; mining activities have created a post-mined landscape of bare mineral soil dotted with tailings ponds and 100 meter-deep holes. Although the wetlands lost by open-pit mining will not be reclaimed in totality, by regulation, the mining of this vast, fen-dominated landscape must be reclaimed to "equivalent land capability", making it one of the world's largest wetland reclamation projects. Our main objective was to provide reclamation benchmarks and reference points to which created marshes of the region can be compared and toward which reclamation practices can be guided. More precisely, we describe and contrast patterns of vegetation composition, function and development in created and natural marshes. To achieve our objectives, plant community data were collected during the summer 2008 to 2013. The plant communities of more than 20 created marshes (varying from 15 to 32 years old) was compared to that of 20 natural marshes. Using univariate and multivariate analyses, we demonstrated that these marsh classes are characterized by different patterns of vegetation diversity, composition, function and development. We identified abiotic factors associated with marsh structural and functional differences. Using a controlled experiment, we have empirically demonstrated that sediment quality may be improved by amending common reclamation substrates with peat-based organic matter amendments. We also show the importance of organic amendments for enhancing performances of *Carex aquatilis,* a plant commonly occupying sub-optimal conditions in oil sands created marshes.

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ASSESSING DYNAMICS OF *RHANTERIUM EPAPPOSUM* PLANT COMMUNITY OVER FOUR DECADES OF PROTECTION BY GIS

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Rhanterium epapposum is the national plant of Kuwait. It is a perennial shrub that is most abundant in central and north Arabia. The plant requires regular rainfall to germinate and survive during winter. The full plant growth is during early summer in May and June. During summer when the temperature exceeds 40 C^o the plant goes through a dormancy period. The mature shrubs are mainly used for grazing and logging.

In the state of Kuwait the plant community is well established at the Sulaybia Research Station (SRS) of the Kuwait Institute for Scientific Research, which has been protected from livestock grazing for almost four decades. The total area of the SRS is 40 km^2 divided into two equal sections. The eastern section, which is 20km^2, was protected since 1975 (Section A) and the western section were protected since 2003 (Section B). The plant community *Rhanterium epapposum* was assessed by utilizing GIS tools in a time series analysis provide by various data sources which include satellite imagery recently purchased (Worldview 50cm 8 Band) some images from Google earth over various time periods and some flight Ariel data from a UAV (Unmanned Ariel Vehicle). The dynamics of the plant community and associated species showed variation in plant cover in the period from 2002-2012. There is a difference in the plant abundance between the two sections with a higher abundance in section A. Both sections were compared to the unprotected areas adjacent to the station. The difference in plant cover and abundance was significantly higher in the station for both sections A and B in comparison to the adjacent unprotected areas. The associated plants whether annuals or perennials seem to dominate in Section B due to early stages of plant succession and recovery of the community. The plant community in Section (A) are well established and reached a climax stage in succession. Results show that the plant community needs more than a decade to reestablish in Section (B) and the associated species will dominate in the early stages of succession. Therefore, more time is needed to bring back the *Rhanterium* community to recover in the newly protected section (Section B).

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BUILDING AND SUSTAINING INTEGRATED MONITORING NETWORKS IN THE FACE OF DECREASING FEDERAL AND ST ATE FUNDING

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The Chesapeake Bay Program (CBP) is a regional partnership that leads and directs Chesapeake Bay Restoration and Protection. In 1984 the CBP created the tidal monitoring program which included water quality monitoring for 26 parameters at over 150 stations distributed over the 92 Chesapeake Bay tidal segments across Delaware, the District of Columbia, Maryland, and Virginia. In 2004, a watershed monitoring network was established as an essential component to reporting, tracking, and modeling stream flow as well as nitrogen, phosphorus, and sediment concentration loads across the Chesapeake Bay watershed which provides the only consistent, coordinated monitoring effort across all seven Chesapeake Bay watershed jurisdictions. The current priority of the monitoring networks is to enhance the assessment and explanation of monitoring information to track progress towards meeting the 2025 targets set by the *Chesapeake Bay Total Maximum Daily Load for Nitrogen, Phosphorus and Sediment* (Bay TMDL).

The CBP is reviewing approaches to ensure the long-term sustainability of its monitoring networks in the face of decreasing federal and state funding. The review process known as BASIN (Building and Sustaining Integrated Networks) has three phases. Phase I of the review process focused on a short-term effort to address the federal funding reduction of the estuarine and watershed water-quality networks in the 2013 fiscal year. Phase II involved the review of anticipated costs of the CBP water quality-monitoring networks forecast out to 2025 and the formulation of long-term strategies to modify and sustain the networks. During phase II CBP reviewed, through panel discussions, how other long-term monitoring programs conduct and fund their networks activities. Through those panel discussions it became clear that monitoring programs across the country are facing similar challenges. In Phase III a coordination of the CBP Scientific, Technical Assessment, and Reporting Team and the CBP Scientific and Technical Advisory Committee is expected to consider CBP monitoring requirements beyond water quality to support the breadth of commitments (such as fisheries, habitat, and land protection) in the new Chesapeake Bay Agreement. This presentation will provide an overview of the BASIN process, and lessons learned through the cooperation of monitoring networks across the globe.

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ASSESSING THE RESTORATION POTENTIAL OF COAST REDWOOD (*SEQUOIA SEMPERVIRENS*) FORESTS USING A CHRONOSEQUENCE OF NATURAL RECOVERY

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The Coast Redwood forests of California are known for their ancient stands of *Sequoia sempervirens*. However, these stands are increasingly rare, as human disturbance has affected 95-97% of the original forest. With the majority of remaining old-growth protected in parks and preserves there is increasing interest in how can second-growth stands can be managed to encourage the development of old-growth conditions. The purpose of this study was to document the process of natural recovery following logging to identity aspects of the forest community that are resilient to human disturbance, as well as those that may require special attention by managers.

Forest composition and structure were examined across a chronosequence (18-130 years) of recovering stands and old-growth reference sites in the central and southern range of the coast redwood forest. A replicated, randomized, plot design was used to collect data regarding canopy cover; size, abundance, and dominance of tree species; abundance of native and non-native understory species; and the occurrence of old-growth habitat features such as fire-hollows, large woody debris (LWD), and reiterated trunks. Single factor ANOVA, two sample t-test, and regression (linear and logistic), were used to analyze recovery trends and to compare recovering stands to old-growth references sites.

Many of the stand characteristics measured, including tree density, canopy cover, dominance of *Sequoia sempervirens,* and species richness reached levels statistically equivalent to old-growth reference sites within a few decades after disturbance. Understory recovery was less evident however, particularly in regard to herbaceous species. While redwood-associates such as *Trillium ovatum*, and *Viola sempervirens* were abundant in some second-growth stands, their cover did not reach levels equivalent to old-growth references sites in all cases. Encouragingly however, non-native species that occurred in younger recovering stands were almost entirely absent in mature second-growth. Old-growth habitat features were largely absent in second-growth stands with the exception of LWD, with quantities and sizes nearly equivalent to old-growth reference sites. Fire hollows appeared only on residual old-growth specimens, but a few examples of reiterated trunks were found on mature second-growth trees.

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USING AN INDIVIDUAL-BASED MODEL TO EVALUATE THE EFFECTS OF CHANGING HABITAT AND MULTIPLE FACTORS ON TIDAL MARSH FISHES

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A spatially-explicit IBM of a tidal marsh community was developed to examine how multiple effects (i.e., low DO, habitat degradation, river pulsing) on individuals can be scaled to population and community responses. The model simulates six species over one year as they feed, grow, survive, reproduce, and move about the tidal marsh habitat grid generally configured to represent a low-elevation coastal *Spartina* marsh in Louisiana. Individual consumption, mortality, and movement are updated hourly, while growth and spawning are of evaluated daily. The six modeled species are grass shrimp (*Palaemonetes pugio*), inland silverside (*Menidia berrylina*), bay anchovy (*Anchoa mitchilli*), sheepshead minnow (*Cyprinidon variegatus*), gulf killifish (*Fundulus grandis*), and blue crab (*Callinectes sapidus*). These species are commonly used as indicator species in risk assessments of coastal waters, are important component species within tidal marsh food, and serve as important links for trophic relay out of the marsh systems when preyed upon by transient young-of-the-year (YOY) fish predators and wading birds. The 2-dimensional tidal marsh habitat grid is comprised of 10,000 cells (100×100), with each cell representing a 4-m^2 area. Each cell is classified as channel, creek, marsh edge, marsh interior, or marsh pond habitat. Whether a particular cell is inundated with water, and therefore accessible to individuals for movement and feeding, depends on the elevation of the habitat cell and the hourly water level simulated across the entire marsh grid. Temperature, salinity, DO, and prey concentration (zooplankton and benthos) vary hourly within each habitat cell.

The model was corroborated with available field data on species densities, spatial distributions, length distributions, and diet composition. Simulation experiments were performed to investigate how changes in individual growth and mortality due to changing habitat configuration and individual-level exposure to varying environmental conditions (i.e., low DO, salinity) over time related to population and community responses. The largest population responses in all six species were to changes in the habitat grid configuration (number and placement of vegetation and water cells). The species responses to the varying environmental conditions over time were subtle to moderate. The tidal marsh community IBM is good for scaling up individual-level effects that have been measured in the laboratory or field to population and community responses that can be observed and validated within the field.

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RESTORING LOST RECREATIONAL USE OF NATURAL RESOURCES AFTER THE *DEEPWATER HORIZON* OIL SPILL

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In addition to restoration of natural resources injured by unauthorized pollutant discharges, the Oil Pollution Act of 1990 and its implementing regulations prescribe a means for the public to realize restoration for impairment to its ability to access and use those resources. Illustrations of lost opportunities to enjoy natural resources through recreation include fishing trips deferred as oil is reported in nearshore waters and boat ramps rendered inaccessible by response activities such as the staging and deployment of containment boom. Natural resource-based recreation is a prominent feature of the culture and lifestyles of communities around the Gulf of Mexico, and consequently, compensation to the public for these losses is an important element of any comprehensive vision of restoration for areas impacted by the *Deepwater Horizon* oil spill.

Projects intended to address lost recreational use have been a part of the early restoration portfolio since the first phase was proposed in December of 2011. An overview of the variety of projects approved and implemented for Phase I as well as those more recently proposed as part of the third phase of early restoration will be provided in the context of a discussion regarding the distinct challenges of developing such projects under the Early Restoration Framework Agreement established with BP.

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LINKING EVERGLADES RESTORATION EFFECTS TO FISHERIES HABITAT: INFLUENCE OF SAV SEASCAPE STRUCTURE AND FISH PREDATION RISK IN BISCAYNE BAY

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Changes in water quality, especially salinity patterns, caused by the management of the Everglades watershed have influenced the seascape structure of submerged aquatic vegetation (SAV) communities in nearshore habitats of Biscayne Bay, a shallow lagoon adjacent to Miami. Fragmentation of SAV seascapes has been documented in areas affected by freshwater discharges from management canals. Here, we assess how fish predation risk (PRE) is influenced by SAV seascape spatial properties in Biscayne Bay. Predation risks often result in changes in foraging and reproductive behaviors, and the spatial distribution of prey organisms. Such effects can cascade through the community by influencing trophic interactions and population dynamics. Based on predation and landscape effects models, prey species are expected to encounter higher predation risk in fragmented SAV seascapes with high edge densities. The PRE within continuous and fragmented SAV seascapes was assessed using baited remote underwater video surveys (BRUVS) and tether experiments using *Farfantepenaeus duorarum* (pink shrimp) as prey. Both BRUVS and tether experiments identified higher predation risk at the edges of SAV meadows and within fragmented SAV seascapes. These results demonstrate how the spatial structuring and fragmentation of benthic habitats can influence important ecological interactions that may influence the structure and resilience of economically and ecologically important fisheries species.

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ENHANCING POLLINATOR HABITAT AND ECOSYSTEM SERVICES IN RESTORATION

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Interest in the conservation of pollinators, especially native bees, has increased dramatically over the past decade. As standard field methods and taxonomic resources have become more readily available, a new sub-discipline of ecological restoration is emerging. In this presentation, I synthesize literature and case studies to provide recommendations and best practices for pollinator restoration and enhancement in both agricultural and natural systems. Soil characteristics, vegetation structure and floristic composition can be optimized to provide nesting and foraging habitat for a wide range of floral visitors. Considering pollinator resources early in site design will enhance the value of the site for pollinators and maximize the ecosystem services they provide.

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A LANDSCAPE-SCALE RESTORATION EXPERIMENT: THE 2014 SPRING FLOOD FLOW RELEASE TO THE COLORADO RIVER DELTA, MEXICO

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The Colorado River delta was once a several-million acre expanse of marsh wetlands, riparian forest, and estuarine habitat located near the river's mouth in Northwest Mexico (Glenn et al. 2001). However, the diversion of Colorado River water for human use in the arid western U.S. and northwestern Mexico resulted in the gradual drying of the delta with a subsequent loss of over 90% of original habitat (Glenn et al. 2001). Very little water has reached the delta since the era of dam construction on the Colorado River (Nagler et al. 2005), and the highly altered hydrologic regime and influx of invasive species have led to the reduction of native plant and animal populations in the delta (Glenn et al. 2001). However, modest flood flow releases to the Colorado River in Mexico have the potential to revive native vegetation along the riparian corridor (Zamora et al. 2001; Glenn et al. 2001).

An experimental pulse flow of water was delivered to the Colorado River delta in the spring of 2014. This engineered spring flood of approximately 130 million cubic meters (105,000 acre-feet) was implemented as part of the U.S.-Mexico binational agreement, Minute 319, an addition to the 1944 U.S.-Mexico Water Treaty. The term of Minute 319 is from 2012-2017, which allows for a 5-year pilot program to implement and monitor the impacts of the pulse flow release. The purpose of the pulse flow is to improve hydrologic and ecosystem conditions in the riparian corridor of the delta in Mexico to support native wildlife, particularly avian species. Although small compared to the spring floods before the construction of upstream dams and reservoirs, the pulse flow is the first transboundary water allocation for the environment.

Teams of scientists from government agencies, universities, and environmental NGOs from both the U.S. and Mexico are measuring the surface flow rates, inundation, ground water recharge, ground water levels and subsurface flows, geomorphic change, recruitment and survival of vegetation, and avian response to the pulse flow release. Monitoring includes on-the-ground observations and measurements, remote sensing, and modelling for both active and passive restoration sites. The results of this experiment may foster efforts to extend the treaty agreement for a longer-term dedication of environmental flows to the delta and may guide future efforts to effectively and efficiently manage water for the environment through pulse flow releases. No results are available at the time of writing of this abstract.

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GUIDANCE ON QUALITY ASSURANCE FOR ECOSYSTEM RESTORATION

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Monitoring is an important component of ecosystem restoration efforts. Monitoring data are used to ensure that planned activities are implemented correctly and are effective in achieving desired outcomes. Monitoring data must be reliable and defensible. Otherwise erroneous conclusions may be reached, resulting in further degradation of an impaired system (false positive) or needless project redesign (false negative), both errors leading to unnecessary expenditures. The challenge for eco-restoration specialists is that little guidance is available to help them ensure the quality of ecological measurements that are often based on visual observations or judgments by field crews.

To address this need, an interagency committee was assembled to prepare quality assurance/quality control (QA/QC) guidance for ecological restoration practitioners. The committee was formed with participants from eight federal agencies.

The guidance that has been developed recommends QA/QC activities during the planning, implementation, effectiveness monitoring, and data review phases of all ecosystem restoration projects. This guidance is being shared through the preparation of a journal publication and a detailed guidance document. Specific examples are provided to convey important QA/QC concepts and tools. A day-long training session was prepared and presented at a recent international conference (SER 2013) to communicate these important concepts and tools to the ecosystem restoration community of practice.

Our goal is to encourage the use of QA/QC practices by ecosystem restoration professionals. We recognize that ecological QA/QC is a rapidly developing field and we welcome the involvement of restoration professionals in the review and improvement of this QA/QC guidance.

FOCUS: There is minimal guidance available to help ensure the quality of ecological measurements for restoration efforts. An interagency committee has prepared guidance that recommends QA/QC activities during the life cycle of eco-restoration projects.

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LESSONS LEARNED OVER 7 YEARS OF ACROPORA RESTORATION AND PROPAGATION IN FLORIDA AND THE CARIBBEAN

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In-situ coral nurseries established in Miami-Dade County and the Dominican Republic have produced a healthy and sustainable source of the endangered staghorn coral, Acropora cervicornis, for use in restoration activities. In addition, many lessons have been learned which will prove invaluable to the future of Acropora propagation and restoration. For example, donor colonies exhibit low mortality due to fragmentation and nursery colonies benefit from high growth rates due to pruning vigor and high survivorship. Increased productivity has been observed due to induced apical formation as well as propagation on various nursery structures. Transplanted corals continue to demonstrate productive growth once outplanted and significantly increase local coral abundance helping to bridge spatial gaps between existing populations. Maintaining genetically diverse populations within nurseries and outplanting sites is fundamental to restoration success as differences in growth and branching patterns exist between genotypes. Spawning of nursery-reared outplants has been observed indicating that restoration activities are indeed contributing to sexual reproduction. Future steps include outplanting to promote thicket formation and create essential habitat for fish populations to significantly contribute to reef community health. While restoration efforts may pale in comparison with the potential scale of natural recovery, propagation and restoration activities utilizing productive coral nurseries have been expanded to ecologically meaningful levels in the past 5 years and are beginning to have a considerable impact on the localized recovery of coral reefs.

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ADAPTATION SOLUTIONS AND ECOSYSTEM SERVICE BENEFITS AT CAPE MAY MEADOWS

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Quantifying the ecosystem service benefits to ecological restoration projects is important for several reasons, such as to help increase buy-in from local communities, to increase the cost-effectiveness of projects, and to attract innovative funding sources. However, quantifying the benefits from ecosystem services can be challenging, due to the high cost and lack of availability of data. In this session, I will present a decision-making rubric that TNC has developed to support ecological restoration practitioners in quantifying the benefits of restoration projects, with an emphasis on coastal restoration and resilience goals. I will then provide examples of metrics and methods for collecting data on ecosystem services. I will close the presentation by focusing on a case study from Cape May, New Jersey, where TNC is evaluating the social and economic benefits of the coastal wetland, beach and sand dune restoration. The Cape May example provides insights into how restoration projects could improve coastal resilience and provide economic benefits from flood reduction and ecotourism.

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DEVELOPMENT OF THE CPRA OYSTER LEASE ACQUISITION AND COMPENSATION PROGRAM (OLACP) – FROM LITIGATION TO LEGISLATION

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The Louisiana oyster fishery is a lease-based industry in which the state has historically leased oyster habitat via 15-year contracts, for a nominal fee. In addition, the state has maintained public oyster grounds from which seed and marketable oysters could be obtained by leaseholders and the public. This system coexisted and competed with the oil and gas industry for a number of years. The introduction of the state's coastal restoration and protection program in the early 1990's complicated this relationship and introduced an additional competing use of state owned water bottoms. Once issued, an oyster lease cannot be cancelled or revoked. Therefore, the state needed to establish a program by which the leases could be acquired. In order to accomplish this, a single, consistent valuation method had to be established. Prior to the adoption of the current Oyster Lease Acquisition and Compensation Program (OLACP), there were many competing valuation methodologies associated with oyster lease harvest rights. Some of these included: damage payments from oil and gas activities; lease auction sale data; recorded sales; judicial awards; and an earlier voluntary acquisition program. These different value indicators will be explored and compared in relation to the current Fair Market Value Appraisal Methodology employed under the OLACP. Their role and relative importance in the development of the OLACP will be explored.

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THE INFLUENCE OF NUTRIENTS ON THE SUSTAINABILITY OF COASTAL WETLANDS

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A primary purpose of this effort was to reconcile why several studies conclude that nutrients have negative impacts on wetlands, whereas many others conclude the opposite. One expected negative outcome of nutrient enrichment is a decrease in vegetative richness near the outfall area through selection of nitrophilous species such as *Phragmites*, *Typha*, and *Zizaniopsis*. However, decreased salinities downstream are likely to enrich species diversity by converting brackish marshes to fresh and intermediate marshes. Introducing nutrient-rich fresh water also necessarily increases flood duration and can lead to flood stress. A few studies indicate that nutrient enrichment decreases belowground biomass. Our mesocosm study on 11 species of wetland plants common to coastal Louisiana resulted in decreased root to shoot ratios, yet belowground biomass doubled. In another study on *Taxodium distichum* and *Nyssa aquatica*, nitrogen loading rates between 0 and 200 gN m^{-2} $year^{-1}$ resulted in a linear increase in belowground biomass production, followed by a decrease at higher loading rates. Furthermore, *T. distichum* growing in an assimilation wetland outfall area has 5-fold greater wood production than elsewhere in the Manchac/Maurepas swamps. Finally, in the 11,000 ha Central Wetlands only one small area has relatively healthy wetlands with strong soils and that wetland was exposed to over 40 years of secondarily treated wastewater. We conclude that the urgency of furthering wetland restoration in coastal Louisiana calls for expansion of carefully monitored River diversions and assimilation wetlands, which should be planted with *T. distichum – N. aquatica* swamps for storm protection amongst other benefits.

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RESTORING PLANTATIONS TO MULTIFUNCTIONAL UNEVEN-AGED FOREST ECOSYTEMS: EXPERIENCES WITH ADAPTIVE MANAGEMENT AT TATE'S HELL STATE FOREST, FLORIDA

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There has been an increasing interest in managing forest stands as uneven-aged structures because of the perception that uneven-aged silviculture has potential to optimize forest resource use for multiple objectives in a sustainable manner. As a consequence, many agencies and private landowners now have a mission to convert the plantations into uneven-aged stands. However, our experience with such conversion and uneven-aged silviculture is limited.

The Adaptive Management Project (AMP) at Tate's Hell State Forest, FL, presents a unique opportunity to investigate the conversion of intensively managed pine plantations to uneven-aged multi-functional forest ecosystems. The objectives of this long-term project are to evaluate the different harvesting strategies which can convert unthinned mature slash pine (*Pinus elliottii*) plantations to sustainable uneven-aged slash pine/longleaf pine (*Pinus elliottii/ Pinus palustris*) ecosystems in terms of species composition (both overstory and understory), forest structure, and productivity (timber yield and carbon sequestration). The plantations were inventoried for their overstory and understory in 2009, and tree marking strategies were developed based on the principles of traditional thinnings and specialized group, shelterwood, and staggered row harvests. The harvests were implemented in 2010-11 in the plantation stands which reduced the initial basal area of 120- 200 ft^2/ac by 30-75 % distributed in different spatial patterns across the residual forest stands. Post-harvest overstory and understory data collection including assessments of natural regeneration and groundcover biodiversity were completed in 2012-13. Over the short and long run, the AMP project will continue to collect empirical data related to ground cover restoration, natural regeneration, and overstory growth responses over multiple harvest cycles. Other restoration activities, such as prescribed fire and seedling planting, have been planned to be super-imposed on the harvesting treatment plots to further examine techniques for converting plantations to multi-functional uneven-aged forest ecosystems. Simulation modeling, using the USDA Forest Service's Forest Vegetation Simulator (FVS), has also been used to investigate changes in structural diversity, timber production, and carbon sequestration following a range of harvesting intensities and regeneration scenarios. We will present and discuss our project concept and design, experimental harvest treatments, initial data, simulation outputs, and other experiences with this long-term project. This will help forest managers develop a perspective about forest conversion and how to design their own project.

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SEED BANK- VEGETATION DYNAMICS ALONG A RESTORATION GRADIENT: IMPLICATIONS FOR RESTORATION OF GROUNDCOVER IN PINE FLATWOODS ECOSYSTEMS OF THE GULF COASTAL PLAIN OF FLORIDA

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Pine flatwoods ecosystems of the Gulf Coastal Plains are among the most species-rich ecosystems in North America and containing high concentrations of endemic, threatened and endangered species in the southeastern United States. Most of the species diversity in these ecosystems is contributed by the groundcover which also enhances habitat for local fauna and produces fine fuel needed to carry surface fires that perpetuate the system. However, intensive silvicultural operations and fire exclusions over a large extent of these ecosystems in the past century has led to a serious depletion of groundcover biodiversity. Consequently, there have been serious efforts in the recent past to restore these ecosystems. We examined the dynamics of soil seed bank composition and structure and aboveground vegetation as it changes with the progression of ecological restoration at a mesic-hydric flatwoods site in north-west Florida. The restoration activities were overstory thinnings and prescribed burnings with varying intensities. We sampled three stand conditions – namely, degraded, partially restored, and restored- representing a restoration gradient for existing vegetation and soil seed bank. A total of 24, 59, 124 species were observed in aboveground vegetation in degraded, partially restored, and restored stands, respectively. Seed densities and species richness in both aboveground vegetation and seed bank increased along the restoration gradient. Seedling emergence resulted in totals of 26, 39, and 64 species and seed densities of 93, 96, and 101 seed/kg in degraded, partially restored, and restored stands respectively. Seed density and species richness in seed bank also varied with soil depth. While higher seed densities were observed in the top 5 cm soil depth in partially restored and restored stands, the degraded stands had highest seed density in the 5-10 cm soil depth. Overall, there was low correspondence between the aboveground vegetation and the seed bank; though, it increased from degraded conditions to the restored conditions. Although 26 species were observed in the seed bank in degraded stands which may contribute to groundcover restoration, many of them were ruderal. Seed introduction (or seed rain) and the restoration activities which intermix the soil may help speed recovery of groundcover.

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AN ECOSYSTEM-BASED APPROACH TO CORAL REEF ECOSYSTEM RESTORATION: UNDERSTANDING THE ROLE OF HERBIVORY AND PREDATOR/PREY INTERACTIONS TO GUIDE THE DEVELOPMENT OF A COMPREHENSIVE CORAL REEF RESTORATION STRATEGY

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The progressive degradation of Florida's coral reef ecosystem has resulted in an increasing number of proactive restoration efforts to restore resiliency and function to this ecosystem. Much of this effort has focused on restoring the physical reef structure with corals. Although these efforts are widely viewed as the first step toward restoring Florida's reef tract, they have often been undertaken without incorporating research to better understand the key ecological processes that will affect long-term success. Consequently, we have initiated research to understand the role of two such processes, herbivory and predator/prey dynamics, in coral reef restoration.

We are assessing the feasibility of restoring a functional population of long-spined urchin (*Diadema antillarum*), a key herbivore, along the Florida reef tract. Advances made in rearing captive-spawned *D. antillarum* has raised the possibility that this species can be produced *ex situ* and established on Florida's reefs. We initiated research to evaluate the behavioral and ecological characteristics of hatchery-reared *D. antillarum* to ensure that their survival rate in the wild would be comparable to wild individuals. The initial cohort of captive-spawned *D. antillarum* exhibited significant differences in sheltering behavior compared to similarly-sized wild individuals. However, subsequent *ex-situ* experiments revealed that when provided with adequate shelter throughout their ontogeny, captive-reared urchins retain normal sheltering behavior. Hatchery-raised urchins also exhibited the same predator avoidance behavior as wild urchins. The evaluation of size- and shelter-specific mortality indicated that there is no size refuge from predation for *D. antillarum*. Hence, ensuring adequate shelter for urchins released onto the offshore reef tract will be necessary to establish a functional population.

We are also evaluating the predator/prey and spatial dynamics between the corallivorous gastropod, *Coralliophila abbreviata* and the carnivorous snail, *Thais deltoidea.* The impact of predation by *C. abbreviata* on corals used in reef restoration efforts has been profound. Our initial experiments have revealed that *T. deltoidea* readily preys on *C. abbreviata*. Consequently, understanding the trophodynamics of these species could aid reef restoration by identifying reef locations where predation upon newly restocked corals could be minimized by the presence of *T. deltoidea,* increasing the probability of the successful establishment of these colonies.

Our research examining the role of herbivory and predator/prey dynamics is still in its early stages. Our vision is to conduct progressively more complex ecological studies based upon this work to guide the development of a holistic approach to coral reef ecosystem restoration.

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DATA AVAILABLE FROM LOUISIANA'S COASTWIDE REFERENCE MONITORING SYSTEM-*WETLANDS*

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The Coastwide Reference Monitoring System - *Wetlands* (CRMS) is a comprehensive, standardized network of 392 monitoring sites funded by the Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) that evaluates restoration projects and informs restoration planning throughout Louisiana's coastal zone. Hydrologic, vegetation, and soil data types are collected at each site to monitor ecological factors important to wetland function. Data collected include hourly water level and salinity, annual vegetation, semi-annual elevation change and accretion, initial bulk soil characteristics, and aerial photography for land:water analysis every three or four years. The CRMS Analytical Teams combine data into analytical tools to assess coastal wetlands at multiple scales for the restoration community. The Hydrologic Index (HI) indicates how primary productivity at a site will likely respond to mean annual salinity and percent time flooded. The Floristic Quality Index (FQI) assesses the fidelity of a vegetative community to a habitat type; invasive species receive lower scores than native species indicative of habitat stability. The Forested FQI (FFQI) utilizes the basal area of trees by species to assess swamps. The Vegetation Volume Index (VVI) combines layer cover and height to provide to assess gross plant volume. The Submergence Vulnerability Index (SVI) assesses a site's vulnerability to submergence due to sea-level rise using elevation change, subsidence, and water elevation data collected at each site. Charts created from each data type and indicies are available at the CRMS website (lacoast.gov/crms2/home.aspx). Charts are delivered through dynamic mapping and chart building interfaces and raw data can be downloaded from CPRA's SONRIS database.

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THE IMPACTS OF STREAM RESTORATION ON THE SOILS AND VEGETATION OF RIPARIAN ZONES IN CENTRAL NORTH CAROLINA, U.S.A.

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Stream restoration addresses degradation by actively returning stream morphology and functioning to pre-disturbance states. Riparian zones are uniquely at risk for exotic species invasions because flooding causes periodic soil disturbance and many exotic species are able to disperse via water, and restored riparian zones are particularly at risk because of the soil disturbance they incur during restoration through the use of heavy machinery to form new channels and floodplains. We studied restored streams in urban and suburban locations within the North Carolina (U.S.A.) Piedmont to determine the extent of exotic plant species invasion and to assess the native woody species. We compared the vegetation of these streams to reference streams, which are used as models for stream restoration design.

We also assessed the chemical and physical properties of the soils at both site types. The restored streams had an average of 34% cover by exotics, whereas the reference sites had 10%. The restoration sites also had more exotic species present per m^2, as well as greater frequencies and higher stem densities of exotic species. The patterns of native woody species cover, frequency, and density also differed by site type. Seventy percent of the soil properties we tested were different among the restoration and reference sites, and soil properties explained 20% of the variation in exotic species cover and 34% of the variation in native woody species cover.

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INSTREAM STRUCTURE DURABILITY AND STREAM BANK EROSION IN RESTORED STREAMS ON THE NORTH CAROLINA (U.S.A.) PIEDMONT

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We evaluated 583 instream structures in 19 restored streams between 4 and 12 years old, focusing on damage to structure components and stream banks. The structures included rock cross vanes, single arm vanes, j-hook vanes, rootwad revetments, and boulder revetments. We also calculated Bank Erosion Hazard Indices (BEHIs) for the restored stream sections and sections of six reference streams. A threshold value for both structure condition and BEHI score was specified, which indicated the point at which structure and bank condition may be questioned. Rock cross vanes and rootwad revetments were the least durable structures, reaching the threshold value in 4 and 6 years, respectively. Single arm vanes and J-hook vanes did not pass the threshold value until 10 and 11 years, respectively. Boulder revetments approached but never reached the threshold value and were the most durable structures. The majority of BEHI scores in restored and reference sections were above the threshold value. No relationships were found between structure condition, structure density, or number of structures per stream and BEHI score. Apparently erosion is the result of large scale disturbances within the watershed to which both restorations and references are reacting similarly.

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DEVELOPMENT AND ADAPTATION OF THE CASM TO EVALUATE FOOD WEB DYNAMICS AND SPECIES RESPONSES IN BARATARIA BASIN

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A version of the comprehensive aquatic systems model (CASM) was developed to simulate species biomass responses in Barataria Basin to the operational alternatives for the proposed sediment diversion at Myrtle Grove. The CASM food web was comprised of phytoplankton, periphyton, zooplankton, zoobenthos, and important consumer species including brown and white shrimp, blue crabs, oysters, bay anchovy, gulf menhaden, largemouth bass, red drum and spotted seatrout. Daily growth of each producer and consumer population was determined by bioenergetics-based equations. Daily inputs for light, temperature, depth, nutrients, suspended sediments and organic matter differentially modified photosynthesis and consumption of the populations. Daily species biomass can also be modified by salinity and structural habitat.

Barataria Basin was divided into 18 polygons and separate CASMs were run in each polygon to simulate the spatial distribution of each species. Polygons were defined to represent areas with relatively homogeneous environmental conditions that were also large enough to minimize the effect of species movement among polygons. The CASMs were run in each polygon using environmental inputs from field data collected between 1999 and 2010. Daily biomass estimates from each polygon were combined to produce estuary-wide biomass estimates using a weighted mean with the results of each polygon weighted based on its area. Estuary-wide seasonal biomass distributions were calibrated to biomasses estimated from LDWF and NOAA sampling programs. The predicted species biomass distributions across the 18 stations were described based on the differences in the environmental inputs and the food web interactions in each polygon. The modeled distributions of key species were evaluated by scientists and managers at NOAA, LDWF, and USFWS to determine if the species parameters, distributions and interactions were realistic.

A fish community modeling approach such as the CASM is good for evaluating species biomass responses to coastal restoration and protection efforts in Louisiana estuaries where food web interactions and bottom-up processes due to changing physical and chemical conditions are important. The CASM can be run using the outputs generated from hydrodynamic and water quality models of the basin in order to evaluate the relative changes in species biomass and distribution due to coastal restoration and protection projects. The CASM approach is particularly useful for evaluating processes that operate on relatively short time scales, such as seasonal or pulsed operations from freshwater diversions, because it incorporates a large suite of daily environmental conditions to modify the food web processes, it simulates daily growth and food web interaction processes via bioenergetics for the component producer and consumer groups, and it has flexible spatial arrangement so that it can be easily linked with existing hydrodynamic and water quality models.

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ALIGNING RESTORATION AND RISK REDUCTION OBJECTIVES? WE'VE GOT AN APP FOR THAT!

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Restoration projects are increasingly being sited and developed with the intention of providing multiple ecological, societal and economic benefits. Habitat restoration projects designed to reduce adjacent coastal erosion are one prime example of a multi-objective project. To identify places where thoughtful restoration can provide multiple benefits and increase coastal resilience, The Nature Conservancy (TNC) partnered with Stanford University to create a first-of-its-kind Risk Explorer App (yes, just like the apps on your phone) that clearly shows where natural habitats—oysters, coral reefs, forests, marshes, seagrass, beaches and dunes—likely reduce risk to people and property along every kilometer of the Gulf and Atlantic Coasts. The Risk Explorer allows decision makers (i) **to assess risk and vulnerability** to waves, storms and sea level rise and (ii) **identify habitat restoration and management priorities** that may be most useful for risk reduction. The Explorer provides both Answers (i.e., a static map) and a dynamic exploration tool.

The Risk Explorer is organized by state and permits users to easily visualize coastal hazards risk as a function of both coastal exposure and social vulnerability. In the "Show Me" section of the Risk Explorer, the user can quickly view where habitat loss may have the greatest impacts on risk and thus where management (including for example restoration to enhance the condition of existing marshes and reefs) is most important for risk reduction. In the Gulf of Mexico, the "Show Me" section also includes maps showing where oyster restoration is most likely to reduce risk and maps showing the variation in median owner-occupied housing values across each state.

This presentation will explain the science behind the Risk Explorer App and how you can use it to engage communities and decision makers on issues related to coastal resilience in your own geography.

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ENVIRONMENTAL REMEDIATION & RESTORATION OF THE KISHON RIVER ISRAEL

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The Kishon River drains the Jezreel and Zevulun Valleys of Israel and empties into the sea at the city of Haifa. Flooding has become a major concern along the final reaches due to sediment deposition, low gradient, and increasing urbanization. Severe floods caused widespread damage during the winter of 1991-92. Flooding risk was mitigated during 1993-99 by dredging some 100,000 m^3 of sediment into lined settlement lagoons along the river perimeter. This dredging ceased in 2000 when regulatory changes deemed contaminant levels too high. Contamination of the river by local industries has also reduced since 2000, and restoration of the river has begun.

Yodfat Engineers, Israel, was commissioned by the Kishon Rivers and Drainage Authority to undertake an evaluation of the sediment contamination and assess cleanup options. Site characterization was assisted by Jones Environmental, UK, who developed analytical methods to differentiate between the weathered petroleum hydrocarbons and background organics present in the Kishon sediment. A range of remediation options, including landfill, thermal treatment, and biophysical treatment were assessed. Remediation projects in North America and Europe were reviewed. Risk-based clean-up criteria were developed through a site-specific assessment by the RAM Group of Gannett Fleming, USA. Yodfat Engineers developed a biological treatment strategy based on cost, reliability and environmental sustainability. Treatability studies performed with MTD Laboratories, UK confirmed that biotreatment was applicable to the Kishon sediment. The plan was carefully shaped to both protect the riparian restoration already achieved and provide a platform for planned future conversion of the area into public parkland.

The final conceptual design by Yodfat Engineers includes dredging some 450,000 m^3 of sediment from 6 km of river and pumping the slurry to a treatment site adjacent to the dredged section. The slurry will be screened and dewatered, and the supernatant treated before being returned to the river. The dewatered sediment will be mixed with material from the lagoons filled during the 1993-99 works, amended with sand and organic additives, and then treated on-site using downward flow vacuum aerated biopiles. Approximately one million tonnes of treated soil will be produced, which will be landscaped over the treatment site and capped with clean soil.

After winning an international tender for execution of the remediation works, EnGlobe Corp has begun preparatory work on-site and will start a 2-year dredging and remediation programme in early 2014. Significant environmental monitoring and quality controls will be included throughout the works. These include daily chemical analyses at an on-site laboratory provided and operated by Jones Environmental, ensuring that area air and water quality is well protected throughout the works. This close monitoring will also assist the contractor and project managers in optimizing the treatment process in real time, and simultaneously certify that the treated soil product is acceptable for future restoration efforts and public recreational use.

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APPLICATION OF HGM IN THE EVALUATION OF THE SUCCESS OF A MISSISSIPPI TIDAL MARSH MITIGATION PROJECT

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The restoration of impacted estuarine systems in the urban environment proposes a number of factors especially associated with the capping pollutants. The existing conditions consisted primarily of debris associated with 100+ years of the historical site use. These impacts are addressed with beneficial modifications to the transition area, intertidal and submerged habitats. Containment was accomplished by the construction of a two foot impervious cap consisting of several layers for protection that extended from the upland into the estuary. The existing tidal fringing wetlands were evaluated using Hydrogeomorphic (HGM) Approach for before construction for post evaluation to determine success.

Over 100,000 plants of five species (*Juncus roemerianus*, *Schoenoplectus robustus, Spartina alterniflora, Spartina cynosuroides*, and *Spartina patens*) were removed, maintained, and incorporated into the fringed tidal wetland restoration as required by state and federal permits. The areas were supplemented with additional seeding and planting with indigenous species in increase diversity and stability. *A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast* (Shafer et at 2007) was utilized in the assessment over the 5 years. An adaptive management plan has been developed for the project to insure the objectives are met for a functioning transition area, intertidal wetland, and oyster reef. The project has received Wildlife Habitat Council Certification in 2012 as part of the *Wildlife at Work Program* and EPA 2011 Region 4 Phoenix Award for Brownfields restoration.

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INTEGRATION OF DISPARATE DATA SOURCES FOR REAL-TIME BEACH WATER QUALITY MODELING ON THE GREAT LAKES

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Beach water-quality managers continue to improve daily water-quality forecasts by developing statistical models to assess nearshore and tributary influences for beaches of interest. Historically, a barrier to developing and operating these new models has been efficient access to relevant and current data. The USGS Environmental Data Discovery and Transformation (EnDDaT) tool was designed to access, integrate and format datasets for calibrating water-quality models using historical observations as well as running models in an operational capacity using real-time measurements and hydrodynamic model output.

EnDDaT helps to convert diverse environmental data into a single product tailored to a specific need. Timeseries of varying frequency can be combined into one result, as well as filtering timesteps based on user specified dates and times. Users can transform raw values into time-windowed statistics including mean, max difference, and standard deviation. EnDDaT can also accept a user-defined shapefile to spatially process radar indicated rainfall data from the National Weather Service. Throughout the 2013 beach season, these processing capabilities were combined into a preconfigured request run daily to determine the status of beach openings.

EnDDaT's request application programing interface (API) and resulting datasets can be directly used in a variety of model development environments. Libraries have been written for the R statistical language and EPA's VirtualBeach modeling software to easily query and import data. Expanding the available EnDDaT toolset has widened the scope and audience of EnDDaT applications. These applications continue to focus mostly on Great Lakes beach modeling efforts, but could be widely applicable for environmental data analysis and modeling throughout the US.

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VEGETATION RESTORATION IN THE EAGLE FORD SHALE OIL & GAS PLAY

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The Eagle Ford Shale oil and gas play (EFS) is one of the most significant oil and gas finds in the continental United States in the last 50 years. Exploration activities, production, and transport of oil and gas have had and will continue to have a major impact on the native vegetation of this region. *South Texas Natives* is an eco-regional plant materials development and restoration initiative headquartered at the Caesar Kleberg Wildlife Research Institute at Texas A&M University-Kingsville. STN and its primary partner, the USDA NRCS E. "Kika" de la Garza Plant Materials Center (PMC), have co-developed 24 native plant germplasm seed sources in the last decade and a half. Most all of the EFS lies within the service areas of STN and the PMC, thus needs for restoration plant materials and appropriate native plant restoration techniques for the EFS rapidly began reaching us in 2008.

Several common widespread problem areas for effective restoration quickly emerged as research priorities in the EFS. Needs centered on 3 types of problem areas: 1) restoration and erosion control on or around man-made ponds, pond dams, and steep embankments (e.g. "frac-tanks) that were being constructed across the landscape to store large quantities of water for hydraulic fracking; 2) restoration of sites generally characterized as "mixed-soil" areas, where trenching for pipeline installation or other construction activities resulted in poor quality planting sites because of the mixing of topsoils with poor-quality sub- soils characterized by high soil salinity and/or alkalinity; and 3) revegetation of 1,000s of ha of new pipeline right of way easements using available seeds of adapted native plants.

In 2008, we began experiments to quantify native plant restoration successes resulting from the common planting techniques used by industry in each of these scenarios, and to quantify the performance of various commercially available native plant seed sources developed by STN and the PMC. Projects were undertaken on active exploration and pipeline construction sites at 3 locations in the EFS area. We will present the results of these experiments, and present the challenges and benefits faced in this work and in garnering widespread adoption of the best restoration techniques by operators. While many successes have been achieved, significant future challenges exists, as do the likelihood of other emerging high-priority restoration research needs over the projected life of the EFS Play.

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USE OF MULTIMETRIC INDICES TO MONITOR ECOLOGICAL RECOVERY

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The implementation of effective restoration monitoring tools is essential to accurately assess restoration progress and to guide adaptive management. To be effective, these tools must integrate diverse monitoring data in a way that is consistent with scientific knowledge and can be conveyed to a range of stakeholders. One such tool is the multimetric index (MMI), which is proven in its ability to assess whole ecosystem status by combining a variety of data types into a single robust index. For this reason, combined with responsiveness and sensitivity to change, MMIs were chosen as the primary tools to monitor the progress of salt marsh and tidal flat restoration sites along the eastern shores of Saudi Arabia under the Coastal Environment Remediation and Restoration Program. MMIs were developed to track two related states: Ecosystem Health MMI for the biological health of restoration sites, and Stressor MMI for the physical and biological conditions contributing to stress at restoration sites.

Metrics integrated into each MMI were created using a selection of 40+ variables collected during bi-annual, (spring and fall) field monitoring events. Stressor MMI metrics, selected based on their association with degraded conditions and expected response to restoration activities, included metrics that focused on oiling conditions and the presence and type of invasive algal mat. The Ecosystem Health MMIs, one for tidal flats and one for salt marshes, included metrics that correlate strongly with high values of desirable variables at healthy reference sites and included diversity indexes, perennial abundance, benthic infauna abundance, and burrowing activity of crabs, among others. All metrics were tested for correlation to each other and calibrated by comparing conditions at three types of sites: reference, set-aside, and restoration. Reference sites are the healthiest sites, representing the closest available reference to unoiled conditions. These sites provided a target range of desirable conditions for restoration efforts. Set-aside sites are those that have similar levels of stress and ecosystem health as the restoration sites, but where restoration activities were not conducted, thus providing a basis for measuring the success of restoration.

The combination of the Stressor MMI and the Ecosystem Health MMI allows for the simultaneous monitoring of the two most important processes: response to restoration activities, and recovery of biological communities. As restoration activities are completed and stressors at the sites decrease, the Stressor MMI values increase. Reductions in stress provide opportunities for colonization and recovery of natural ecological processes. Therefore, gains in abundance, diversity, and the extent of biological communities are quantified with the Ecosystem Health MMI. Over time the Ecosystem Health MMI values show a change in the trajectory of recovery at the restoration sites, with MMI values increasing more rapidly for restoration sites than for set-aside sites. Through the combination of diverse metrics and careful calibration to project-specific sites, the MMIs developed for the CE-RRP have proven to be reliable indexes that quantify both the effects of restoration activities and changes in the rate of ecological recovery.

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THE BILLION BOTTLE BARRIER: A WORLD CITIZEN-SCIENCE PROJECT FOR MITIGATING COASTAL EROSION

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Using sand-filled glass bottles contained in polymer mesh bags and connected with nylon rope, heavy erosion-resistant barriers can be placed to protect eroding marsh lands by allowing natural colonization by aquatic vegetation and marine animals. These linear connected barriers would also allow for sediments to be trapped behind them and the opportunity for reestablishing natural marshlands in a less turbid environment where sediments could collect.

One of the reasons for the rapid advance of coastal erosion is that oyster banks were dredged off the Louisiana coast to provide foundation materials for coastal structures. Without strong structural elements, shellfish have a difficult time in reestablishing protective barriers on loose substrates. This need has been partly met by returning oyster shells to coastal waters, but in places where land-sourced shell sources are scarce and quarry rock is expensive, glass bottles which otherwise might be thrown in landfills and salvaged polymer fruit bags may be used to construct nearly chemically inert synthetic barriers that can be engineered to direct sediment where it would be most useful.

Bottles would be filled with sand and temporally sealed shut with waste paper toweling or other non-printed paper, collected in polymer bags, linked together with nylon rope and placed in an interlocking position and sunk in front of the wetland that is to be protected. The natural irregularities of the bottles' shapes and any embossing would aid vegetation and shellfish attachment to this synthetic substrate. Sediments would also accumulate that would serve to help consolidate the barrier. Almost immediately, small fish and crustaceans would be attracted to this area where the many open spaces between the bottles and their open necks, once the paper rotted, would allow breeding and egg-laying areas for many species.

This unproven technology needs to be tested. It was started as a Kickstarter project to encourage citizen scientist from around the world to initiate pilot projects in a variety of fresh, salt and brackish-water environments on private land to determine how long it took these bottle barriers to be colonized by vegetation and how effective they were at trapping sediment. Information from these projects is to be combined into a single database to provide a resource for scientific study and ultimately, state and national approvals for its world-wide implementation.

Once such approvals are obtained, school children could bring their washed and sand-filled bottles to a collection spot for transport to distribution sites for placement in critical areas. This way every citizen in every nation could have a personal involvement in protecting their nations' vital coastal environments.

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MARITIME GRASSLAND CREATION AND SHORELINE STABILIZATION

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White Island, a former 80-acre municipal landfill located in Brooklyn, New York, was recently transformed from an invasive species dominated, severely eroding island, into a rare maritime grassland habitat for the City of New York Department of Parks & Recreation. The project served as compensatory mitigation for the loss of 56 acres of grassland habitat which occurred during construction of a nearby housing development and retail center and is one of the first grassland mitigation projects required by New York State. The main objectives of the restoration design were to:
Control invasive species;
Stabilize the degraded shoreline;
Increase biodiversity; and
Create diverse grassland habitat for rare or special-status bird species.

Construction activities included the installation of 150,000 CY of sand across the island surface to create a planting substrate free of invasive species for the establishment of warm-season grasses. A significant portion of the design was to stabilize the island's severely eroded shoreline and thus prevent waste from discharging into the adjacent tidal resources. Slope stabilization techniques included a mixture of conventional (armor stone) and various bioengineering practices (articulated concrete block and cellular confinement systems).

The planting design incorporated several vegetative zones (tall grass meadow, short grass meadow, maritime grassland, dune and salt marsh planting) to attract ground nesting bird species with varying habitat requirements for nesting and foraging (e.g., Vesper Sparrow, Grasshopper Sparrow, Bobolink, Henslow's Sparrow and Upland Sandpiper). Incorporating vegetation solutions (i.e., bioengineering) to solve the shoreline erosion problem provided a connective vegetated zone along the shoreline for wildlife use.

Observations of the vegetative growth within the first year of establishment indicate the seeding and planting techniques utilized were successful within the grasslands, dunes, shoreline and wetland restoration areas. In the fall of 2012, the island received a 15 foot storm surge during Hurricane Sandy, with no erosion or loss of vegetation, thus demonstrating the superior performance of sustainable bioengineering practices.

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REBUILDING AN ISLAND TO RESTORE BIRD NESTING HABITAT FOR SPECIES INJURED BY THE DWH SPILL

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North Breton Island, located at the southern end of the Chandeleur Island chain in Louisiana, is part of the Breton NWR established in 1904 by Theodore Roosevelt. Breton NWR is recognized as a globally important bird area because of the bird resources it provides, and hosts one of Louisiana's largest historical brown pelican nesting colonies. However, recent surveys indicate that this colony has declined dramatically, including a reduction of approximately 50% of breeding pelicans between 2008 and 2012. Loss of island area through relative sea level rise, diminished sediment supply, and storm impact constitutes a major and ongoing threat (Lavoie 2009; Martinez et al. 2009; Kindinger et al. 2013). Without actions to restore sand into the island platform system, North Breton island is expected to completely submerge sometime between 2013 and 2037 and evolve into a re-emerging sand bar (Lavoie 2009), rendering the island unusable by nesting seabirds.

Brown pelicans, terns, skimmers and gulls were some of the representative birds injured by the Deepwater Horizon oil spill. As part of the Natural Resource Damage Assessment and Restoration process, the natural resource trustees for the spill proposed to conduct restoration activities at the island to partially compensate the public for injuries to these bird species by restoring beach, dune, and back-barrier marsh nesting habitats to support additional nesting brown pelicans, terns, skimmers and gulls.
Proposed restoration work incorporates proven techniques and established methods used in other Louisiana barrier island restoration projects. However, the location and site-specific dynamics of the island system pose unique engineering and design challenges. To overcome these challenges, the project design team is using cutting edge methodology and modeling to evaluate the location of sand resources, potential changes in wave patterns following project implementation, and longevity of restoration design options. To take advantage of the physical processes supporting the natural movement of the island inland, restoration actions facilitate natural evolutionary processes, including longshore and overwash transport of sand. Restoration design will be guided by results of geophysical and geotechnical surveys, previous studies regarding Chandeleur Island dynamics, and data guiding habitat management supporting breeding target bird species. Proposed restoration would use approximately 3.7 million cubic yards of sand, silt and clay material dredged from borrow site(s) identified by the geophysical investigations. This sand, silt, and clay material would then be placed on the existing submerged island to create the desired island configuration. Planting and the use of sand fencing in the dune area and planting back-barrier marsh will facilitate nesting habitat development for pelicans and gulls, as well as help stabilize the island. DOI is actively working with the State of Louisiana, NOAA, USACE, EPA, and other stakeholders in project design and implementation.

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EFFECTS OF THE RECORD-BREAKING CALIFORNIA DROUGHT ON THE DENNERY CANYON WEST VERNAL POOL RESTORATION SITE

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The Dennery Canyon West Vernal Pool Restoration Site is mitigation for impacts to vernal pools and federally listed fairy shrimp species (*Branchinecta sandiegonensis* and *Streptocephalus woottoni*) and Quino checkerspot butterfly (*Euphydryas editha quino)* habitat from the expansion of a nearby freeway. It was installed in 2008 and during the record-breaking drought of 2013-2014; the restoration site was in Year 5 of a 6 year maintenance and monitoring program. The drought is not expected to have long-term consequences on the success of the site but the effects during Year 5 were dramatic. Only 13 out of 40 pools ponded at all and these only ponded once and for less than a week. Therefore no fairy shrimp were observed at the site. Additionally, the upland cover of annual species across the site is nearly 0% compared to the usual 40%. If the 2014-2015 rain year is normal, the site should recover completely. However, if the State of California continues to experience an extreme drought, there could be concern for the long-term success of the site.

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THE CHANGE IN ECOSYSTEM SERVICES VALUES AND LONG TERM ECONOMIC IMPACT RESULTING FROM COASTAL RESTORATION INVESTMENTS

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Coastal ecosystems are some of the United States' most important and vulnerable natural resources. While coastal restoration has potential to greatly enhance ecosystem goods and services that provide substantial economic value to nearby and distant communities (e.g., Johnston et al., 2002), quantifying longer-term benefits of habitat restoration can be challenging (Pendleton, 2010). This lack of information on the long-term economic effects of habitat restoration reduces environmental managers' ability to accurately assess alternative projects or fully evaluate the benefits of local or regional habitat restoration programs. To demonstrate potential value of the ecosystem service flows resulting from coastal restoration, our study analyzes changes in ecosystem goods and services created or enhanced by three major coastal restoration projects (South San Francisco Bay, Virginia Seaside Bays, and Alabama's Mobile Bay) and estimates the monetary value of the enhancements. We selected these sites as case studies representing the diversity of projects completed under the American Recovery and Reinvestment Act (ARRA), which in 2009 authorized allocation of $167 million in funds for coastal and marine habitat restoration. Restoration efforts at the case study sites cost from $2.1 to $7.6 million per site, and were designed to create or enhance locally-critical habitats including coastal tidal marsh, salt ponds, oyster reefs and submerged aquatic vegetation.

To characterize the restored or created ecological functions and services at each site, we first use monitoring data and other literature to compare pre-and post-implementation ecological conditions. To project long-term changes in these conditions, we extrapolate existing data along site-specific habitat restoration trajectories. We then estimate the net changes to ecological good and service endpoints associated with restored habitats, including carbon sequestration, fisheries productivity, and coastal erosion. Where possible, we then use a mix of market- and non-market based benefit transfer approaches to estimate the present value of long-term benefits of each endpoint. We also apply U.S. EPA's environmental justice framework to examine the distribution of benefits across various socio-economic groups.

We use the results of the Virginia Seaside Bays restoration case study to demonstrate our methods and findings, and to characterize uncertainties in the estimated values. Restoration activities at this site (2009-2011) included construction of 22.1 acres of oyster reefs; planting of 133 acres of non-vegetated bottom with eelgrass seeds; and deployment of about 136,000 adult scallops as spawning stock in the restored eelgrass beds. Preliminary results suggest monetized long-term ecological benefits may substantially exceed the project's cost; illustrate "lessons learned"; and provide an example that can be used to educate local stakeholders about the range and longevity of economic benefits that can arise from successful coastal restoration projects.

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INTEGRATING ADAPTIVE MANAGEMENT INTO NEPA PLANNING TO EXPEDITE LARGE-SCALE ECOSYSTEM RESTORATION/RECOVERY IMPLEMENTATION

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This panel session will examine a growing trend within large-scale ecosystem restoration/recovery programs involving the integration of adaptive management principles into NEPA planning and documentation. The primary reason for this development is the recognition of the scientific uncertainty associated with restoration/recovery efforts and an inability to accurately predict ecosystem response to proposed management actions. While adaptive management helps reduce uncertainty and improve decisions, federal agencies must apply NEPA to management action changes. Thus, the integration of adaptive management has expanded the traditional approach to NEPA planning and presents new challenges to agencies including development of alternative management actions to address ecological uncertainty, predicting ecological response over a range of potential outcomes and calculating the cost/benefits of restoration/recovery in a manner that allows comparison with other programs across the Country.

The session will involve a combination of a brief presentation from four different large-scale restoration/recovery programs (i.e., Everglades, Louisiana Coastal Area, Missouri River, and Upper Mississippi River) followed by a panel discussion to address issues common to each program. Each panel member will provide a description of how their individual restoration/recovery program addresses the challenge of incorporating adaptive management components into the NEPA planning process. These presentations will be followed by a discussion of how the inclusion of adaptive management has altered the NEPA planning process and the how these changes are being communicated to decision-makers and the public.

The intended audience is managers, restoration/recovery practitioners, planners, and others who prepare NEPA documentation for large-scale restoration programs. Lessons learned will be shared with scientists/planners who are involved in ecosystem restoration/recovery adaptive managements and are requested to make recommendations of how to include uncertainty in the delineation of management actions.

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CAN URBAN DEVELOPMENT RESTORE AQUATIC RESOURCES WITH STANDARDS FOR STORMWATER RETENTION AND LANDSCAPE PERFORMANCE?

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Washington DC—locally known as the District—shares the common ultra-urban experience that comes with development, increased stormwater runoff. As a city grows, either outward or through infill, it places a burden on older storm sewer systems designed for lower density, smaller impervious footprints. Unmanaged stormwater runoff overloads the capacity of streams and sewers with downstream impacts, such as flash floods, channel erosion, surface water pollution, and aquatic habitat degradation. Can strong local environmental regulations for development turn back the clock and improve the ecology in receiving urban water bodies?

The District was an early adopter of mandatory on-site stormwater management passing a 1988 regulation requiring most new development to incorporate water quality and quantity measures to control peak hydrographs and first flush events. Twenty-five years later, the resulting flow control structures do not adequately mimic predevelopment conditions, as hoped. They often artificially create more frequent channel shaping events and the first flush volumes do not sufficiently reduce the pollutant loads. Many stakeholders are looking at the District's newly enacted 2013 Stormwater Retention Standards as the latest cutting edge of development regulation. The retention standard acts as a complement to the approaches of the late eighties by adding the requirement for development to manage onsite most small annual daily maximum events which translates into a fourfold increase over existing obligations. This presentation will explain the District's interpretation of "retention" and broadly review the designer's retention best management practice (BMP) tool box, as well as the effect of land cover types.

The 2013 stormwater regulation is not the only new regulatory initiative expected to improve aquatic conditions. The District's Office of Planning enacted a 2013 zoning regulation aimed to advance landscape choices on new development sites to reduce stormwater runoff, improve air quality, and cool the city. The zoning regulation, dubbed the Green Area Ratio (GAR), uses the framework derived from Seattle's Green Factor to require most properties seeking occupancy permits to achieve a zone specific score that represents a ratio of vegetated surfaces to the property footprint.

A comparison of compliance with the GAR and the Stormwater Retention Standard will evaluate how these regulations overlap to produce a common metric of gallons of stormwater retained on-site. Evaluating the medium term and long term projected development rates by square feet (Washington DC Economic Partnership 2012) we can predict the retention volume development will provide. Mapping major development projects, projected development trends and project types over stream networks we observe how these may impact head water tributaries.

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ASSESSING FUNCTIONAL EQUIVALENCY AT MULTIPLE SCALES USING THE COASTWIDE REFERENCE MONITORING SYSTEM

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Restoration projects are often implemented with long-term monitoring programs in place to assess the trajectory of a manipulated system with regard to some reference system or targeted benchmark. To determine the ecological status of a restored system, and thus assess the success of a restoration effort, monitoring programs should include measures of not only ecosystem structure, but also ecosystem function and resilience. Although ideal, it is not always possible to conduct exhaustive ecological studies that include measures of ecosystem function in pre-selected restored and reference sites. In 2003, the Coastwide Reference Monitoring System (CRMS) was implemented to provide a reference condition for the assessment of restoration projects being employed under highly variable conditions. The CRMS network has facilitated the creation of a comprehensive dataset that includes, but is not limited to, vegetation, hydrologic and soil metrics collected from 392 wetland monitoring sites across five wetland community types and nine hydrologic basins across coastal Louisiana. This robust data set allows interested parties to assess the ecological condition of a restored system at multiple scales.

A team of scientists from state and federal natural resource agencies and universities has developed approaches to synthesize CRMS monitoring data to provide multi-scaled evaluations of Louisiana's coastal wetlands. Several indices focusing on vegetation, hydrology and landscape change have been developed to facilitate data synthesis and interpretation. The Submergence Vulnerability Index (SVI), described here, integrates ecological functions including wetland surface elevation change and surface accretion with hydrologic data to assess the vulnerability of a wetland based on its ability to keep pace with projected sea-level rise. The SVI represents the interaction between site-specific measurements of surface elevation dynamics and site-specific relative sea-level rise and, therefore, is not constrained by the differences in temporal and spatial scaling that are present when comparing regional records of sea-level rise and site-specific metrics. We describe the development of this index and provide examples of how it can be incorporated into monitoring programs at project, hydrologic basin, and coastwide scales to assess functional equivalency in terms of surface elevation change and vulnerability to sea-level rise.

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HOW DO ECOLOGISTS MEASURE RESILIENCE?

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The concept of resilience has been widely adopted by ecologists, environmental managers and policy-makers. Maintaining or restoring ecosystems that are resilient to human-induced disturbances has become one of the primary goals of modern-day intervention and stewardship. Yet the confusion about how to define and measure resilience has largely prevented the application of the concept to the practice of ecosystem management.

We recently reviewed the ecological literature to determine how resilience is being measured. We identified five seminal papers that have contributed to the conceptual and empirical development of resilience concepts (including the three listed below). We searched for papers that cited these seminal papers and found 959 papers. Over half of the papers (n= 543 papers) included experimental (manipulative or observational) data, and of these, 189 papers (35 %) measured ecosystem response to a disturbance.

Next, we scored matches between the definitions provided in each of the papers with their measures of resilience. A majority of papers defining resilience as either ecological resilience or engineering resilience did not include measurements that captured their reported definition. Ecological resilience is the ability of a system to absorb change and disturbance and still maintain the same relationships between populations or state variables (Holling, 1973). Engineering resilience is the time taken for recovery after disturbance (Pimm, 1984). Conversely, a majority of papers defining resilience according to Westman (i.e., resilience is the degree, manner, and pace of restoration of initial structure and function in an ecosystem after disturbance) provide resilience measures that were consistent with his definition (Westman 1978). Papers based on either the ecological or engineering definitions of resilience used similar measures, and this was true regardless of whether their definitions matched their measurements.

Overall, there is more data describing ecosystem response to discrete 'pulse' disturbances compared with data for longer term ('press') disturbances. Large-scale, long-term datasets are more commonly available for plants than for other kingdoms. We discuss the implications of our findings for predicting and managing the different forms of resilience in ecosystems subject to human-mediated disturbances.

Holling CS (1973) Resilience and stability of ecological systems. Annual Review of Ecology and Systematics 4: 1–23.

Pimm SL (1984) The complexity and stability of ecosystems. Nature 307: 321–326.

Westman WE (1978) Measuring the inertia and resilience of ecosystems. BioScience 28: 705–710.

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URBAN ECOSYSTEM RESTORATION: UPPER NINTH WARD

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Our work as part of a design studio focuses on the Upper Ninth Ward in New Orleans, Louisiana. We began by closely examining the hydrological systems that formed (and transformed) the area on a city scale, and discovered that the most logical methodology of analysis for the neighborhood scale is the examination of an urban ecosystem.

A scientific analysis of the problems in this neighborhood has guided us to a retroactive investigation of the original wetlands. It is during this period that the landscape was in its most sustainable, natural state. The conclusions to follow were all drawn from scientific study of natural ecosystems. We believe that a paradigm shift will lead to new urban ecosystems that have the smallest possible impact on the natural settings that preceded them.

Our research seeks to show that in order to ensure a truly sustainable way of living for New Orleanians we must detach ourselves from conventional methods of analysis and design. By comparing the neighborhood to that of a natural ecosystem we are finding more ways to accept the inevitability of changing circumstances brought on by global climate change. The rising sea levels, increased intensity and frequency of floods, storms and hurricanes all over the world will be the challenge *par excellence* for coastal cities across the globe. New Orleans offers a unique setting to test new methods and innovative ideas.

The main goal is to eliminate the distinction between built and natural ecosystems and instead address them both as equitable species of the environment. By doing so our methodology attempts to place the design of a sustainable built ecosystem at the core of its values. Our approach is unconventional in the sense that it closely examines the diversity of built environments while ranking all data found in a scientific, value-free manner. We have found that in order for this neighborhood to be rebuilt in the most enduring of ways we must embrace the diversity in all areas, be they ecological, economical or sociological. The most sustainable natural landscapes are those which house the widest range of biodiversity. Ideally, the reconstruction of this neighborhood would employ a new level of biomimicry. Our approach is based on the assumption that all factors in an ecosystem are links in a circular chain, be it built or natural. This change in the viewing of built environments gives us a new appreciation of their assets.

Our proposal will seek to incorporate these features in a most sustainable way and in turn create an urban ecosystem that will last for generations to come.

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ECOSYSTEM SERVICE VALUATION FOR WETLAND RESTORATION

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The concept of "value" in regard to ecosystem services has become muddied and confusing for even the most acute researchers and practitioners. Indeed, the concept of "value" to an economist when compared to an ecologist's perspective will more often than not lead to two very different definitions. An economist will generally equate "value" with "market value" - the monetary amount that an individual is willing to pay for a commodity or service. An ecologist might define "value" by ecological function – the ability of specific functions to perform and the value of their contribution to the overall health of the ecosystem. For example, in Vermont, a high-value wetland (a.k.a. "Class 1") is considered to be exceptional or irreplaceable in its contribution to the state's natural heritage by providing one or more "functions or values" at a very high level.

To the general public, however, the term "value" is often associated with principles and ethics. For example, a common slogan such as "family values" is intended to convey an ethical position in regard to family structure. At best, the term "value" is ambiguous and it has led to significant debate over what "values" should and can be included in any kind of ecosystem service valuation as well as how to measure them. At worst, its ambiguity has led to the dismissal of ecosystem service valuation efforts that were either not inclusive enough of less tangible values (such as cultural norms and traditions) or produced questionable estimates of economic value due to a lack of explicit market data.

This conflict of semantics coupled with the specialization of professional fields (i.e., the "silo effect") creates challenges for wetland managers and those in the field of wetland restoration who need to communicate the expected benefits of a proposed wetland restoration project in a language that is meaningful and clearly articulated for a broad audience of stakeholders. Many current decision-making frameworks utilize benefit-cost analysis as a tool to weigh trade-offs, but it is a process better understood by economists than by many wetland scientists and one that involves several significant limitations and assumptions.

Many of the intrinsic and implicit benefits of wetland functions for society are unaccounted for in the market system. Therefore, communicating restoration project benefits, and hence, generating political and financial support for wetland restoration can prove difficult - even more so when faced with a stagnant or bearish economy. Ecosystem service valuation is a technique which can aid in the development of public and political support for wetland restoration projects by deriving monetary values as well as relative value indicators (quantitative and qualitative) for many non-marketed benefits produced by wetlands. If performed well, it can provide a more balanced perspective of the costs of wetland restoration against a more comprehensive consideration of the associated benefits.

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AN ADAPTIVE MANAGEMENT FRAMEWORK DRIVEN BY COMPREHENSIVE MONITORING AND MODELING INVESTMENTS

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Ecosystem and environmental restoration projects are complex and dynamic. It has been difficult for traditional project management structures to respond to unpredictable ecosystem system response and rapidly changing conditions. Managers have a critical need to monitor their restoration and management actions and if necessary, "adapt" to increase restoration success. Adaptive Management (AM) is an iterative science-based process that accepts uncertainties in ecological systems and uses best available science and technology such as research, modeling, experimentation, monitoring and evaluation to address uncertainties. AM allows for continual assessment to improve or adapt restoration and management actions as a project/program moves from planning to design and construction and, eventually, to monitoring and evaluation.

The need for AM in coastal Louisiana is understood at the Federal, State, and local levels with different AM frameworks and programs evolving to ensure they are successfully incorporated into restoration efforts at both the individual project level and system-wide scales. Project level monitoring and modeling have been conducted to support restoration projects for decades, but the data have not always been utilized to update knowledge, resolve uncertainties and make better management decisions. Two significant events in 2007, the authorization of the Water Resources Development Act (WRDA) and the approval of the State of Louisiana Coastal Master Plan, placed an explicit mandate to incorporate comprehensive monitoring and adaptive management into ecosystem restoration projects conducted by the U.S. Army Corps of Engineers (USACE) and State of Louisiana, respectively. This mandate, together with significant investments by the Coastal Wetlands Planning, Protection, and Restoration Act in the Coastwide Reference Monitoring System (CRMS), allowed for the development of an integrated system level monitoring and modeling program to support evaluations of numerous restoration alternatives over the next 50 years and consider uncertainties such as climate and sea level rise. Two large-scale efforts underway to build AM into restoration planning and implementation will be showcased, the USACE Ecosystem Restoration Adaptive Management and Monitoring program and the Adaptive Management Framework for Coastal Louisiana developed for the State of Louisiana's Coastal Master Plan. The presentation will explain the process and phases of the Louisiana AM frameworks and illustrate how comprehensive monitoring and modeling tools can help address critical uncertainties such as "How much sediment delivered by freshwater diversions will accrete on marsh surfaces and will it be sufficient to keep pace with rising sea levels?"

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DAVIS POND RIVER DIVERSION PROJECT: PRE-AND POST-DIVERSION TRENDS FOR SALINITY INTRUSION AND NUTRIENT REMOVAL

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Draining 40% of the conterminous United States, excess loading of nutrients from the Mississippi River basin has been identified as a key contributing factor for the occurrence of widespread hypoxic "Dead Zone" conditions in the Northern Gulf of Mexico. Regulatory policies and management controls are needed to reduce nutrient sources from all upriver states of the basin as well as local nutrient management strategies in Louisiana. Mississippi River diversion projects, originally designed for restoration of the vast coastal wetlands of Louisiana and mitigation of salinity intrusion, have also been shown to be effective for nutrient assimilation and reduction of nutrient loading to the Gulf of Mexico coastal waters. River diversion projects have thus emerged as a key component of Louisiana's Nutrient Management Strategy and the 2012 Coastal Master Plan. One strategic action for Status and Trends of the Nutrient Management Strategy is the evaluation of trends in nutrients related to river diversions.

Using data from the USACE, USGS NWIS, US Environmental Protection Agency STORET, Louisiana CPRA, and NOAA's NODC, the status and trends of salinity and nutrients before (1997-2002) and after (2003-2010) river diversion has been analyzed to evaluate the effectiveness of the 3760-ha Davis Pond diversion project for control of salinity intrusion and removal of nutrients in a freshwater marsh and wetland. The outflow from the Davis Pond diversion, located near Luling, LA in the Upper Barataria Basin, enters Lake Cataoutche and Lake Salvador and is routed through the Barataria BAY system into the Gulf of Mexico. Pre- and post-diversion results to be presented include: (a) mass balance estimates of removal efficiency and rates for Davis Pond; (b) spatial distributions of salinity and nutrients along a path from Davis Pond to Barataria Bay and the Gulf of Mexico; and (c) mixing diagrams of salinity vs. nutrients. A key feature of the trends analysis is that seasonal salinity and nutrient data has been filtered for a range of low, normal and high Mississippi River flow and diversion flow conditions to clearly detect pre- and post-diversion "signals" of seasonal and inter-annual changes from the "noise" of all the data collected from 1997-2010.

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RESTORING FISH PASSAGE ON WHITEMARSH RUN

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Whitemarsh Run, a third-order coastal plain stream draining to the tidal Bird River in Baltimore County, Maryland, has been severely impacted from historic sand and gravel mining in the stream channel and floodplain. Mining impacts include increased sediment loads, channel erosion, channel destruction, loss of riparian buffer, and a 5-foot vertical fish barrier downstream of the U.S. Route 40 crossing. Several stream restoration projects have been completed on Whitemarsh Run, but those reaches are not accessible to anadromous fish due to the U.S. Route 40 fish barrier. It was agreed that restoring fish passage and stabilizing rapidly eroding streambanks would satisfy the mitigation requirements for streams impacted by the I-95 Express Toll Lanes, Section 100 project (12,199 linear feet). Straughan Environmental, Inc. studied the hydrologic and sediment transport regimes on Whitemarsh Run, assessed through stream gages, discharge and bedload measurements during storm events, and sediment transport modeling, and concluded that a 1,400-foot stone Riffle Grade Control (RGC) structure was the most effective means to permanently reestablish passage for anadromous and other native fish.

Design constraints included a minimum flow depth and maximum flow velocity to provide fish passage during spring baseflows, structural stability during the 10- and 100-year discharges, competence and capacity to transport existing bedloads, maintenance of the existing floodplain elevation along U.S. Route 40, and strict grading limitations due to measured diesel fuel soil contamination and utility right-of-ways. Extensive hydraulic and sediment transport analyses (HEC-RAS, iSURF, various stone sizing and gradation equations) were solved iteratively to design a stable structure, constructable from a mixture of regional stone sources, that would maintain the minimum baseflow depth, not exceed the maximum baseflow velocity, promote surficial flow, transport bedload, include fish resting areas, and not increase the floodplain elevation over U.S. Route 40.

Wetland enhancement and preservation, vernal pool construction, invasive species eradication, and native plantings are also planned on the 184-acre mitigation site. The total estimated construction cost is $4.86M.

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GREEN BULKHEADS IN THE CUYAHOGA RIVER NAVIGATION CHANNEL

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Cleveland's Cuyahoga River navigation channel is an important passageway for maritime commerce, but is a daunting corridor for "transient" fish. For these fish, the ability to migrate upriver to spawn as adults and downriver to return to Lake Erie as juveniles is critical to their survival. Since 2006, the U.S. ACOE has been developing, testing and implementing technologies to create habitat for larval and juvenile fish while maintaining the channel for navigation. Building on lessons learned through Phase I and II of the project, the Cuyahoga County Planning Commission initiated Phase III to explore options for retrofitting bulkheads to provide both navigational and ecological function. The process for Phase III follows "Biomimicry Thinking," a design approach that seeks solutions by emulating nature's patterns and strategies.

The project team has identified desired functions (shelter and nourishment) and defined project context, which includes designing the retrofit to withstand large sediment loads within the channel. The conceptual design stage is looking to biological models for inspiration. Prototypes will be implemented for monitoring in 2014. The presentation will describe the proposed bulkhead retrofit and its potential application to other urban waterways.

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FUSING EASTERN AND WESTERN OUTPLANTING PRACTICES FOR SUCCESS: THE LEBANON REFORESTATION INITIATIVE

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Lebanon has a long history of deforestation dating back to the pre-Phoenician era and has only recently begun to focus efforts to restore forest cover. Unfortunately, seedling survival from initial restoration projects has been poor. Recently, the Lebanon Reforestation Initiative (LRI), a US AID funded effort to build community capacity to restore their lands, has achieved a fundamental transformation in the way tree seedlings are produced and planted in Lebanon using the Target Plant Concept. For outplanting practices, this shift has blended proven traditional methods, tools, and materials with innovative and scientifically supported Western-based approaches. Based on observations and collected data, changes have been implemented in planting timing, hole preparation, planting tools, and moisture conservation. Spring 2013 monitoring in areas where improved practices and high-quality container seedlings were used shows improved survival and vigor compared to surveys from the previous year. LRI is working closely with each community to insure these outplanting practices become ingrained and adopted in the long-term.

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TARGETED APPROACHES FOR PRIVATE LANDS CONSERVATION

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Natural Resources Conservation Service (NRCS) has provided technical assistance to help private landowners address soil, water and related natural resource concerns for many years. Conservation program funding saw a growth period in recent years beginning in the mid-1990s. The new Farm Bill maintains a strong focus on conservation by streamlining and consolidating programs and by increasing the emphasis on targeting, leveraging, and outcomes to improve effectiveness. This presentation will cover how traditional locally led approaches have become more effective in addressing priority natural resource concerns, how landscape initiatives have helped to accelerate conservation efforts in targeted areas, and how the recent Farm Bill provides exciting, new opportunities through the Regional Conservation Partnership Program (RCPP) to further improve targeting and results-orient conservation with limited federal resources.

An overview of the locally led conservation process will be provided as used in Arkansas to improve program delivery for the Environmental Quality Incentives Program. Tools such as state and local resource assessments and local funding pools to help improve effectiveness in addressing priority natural resource concerns will be described.

Landscape initiatives have been utilized by NRCS to more effectively address priority natural resource concerns since 2009 by delivering systems of practices to the most vulnerable lands within geographic focus areas. Through these initiatives, NRCS seeks to accomplish: conservation beyond boundaries, a science-based approach, build on existing locally-led efforts and partnerships, and achieve regulatory certainty for agricultural producers.

Examples will be provided for several landscape initiatives including the National Water Quality, the Mississippi River Basin Healthy Watersheds Initiative, and the Sage Grouse Initiative. Information will be provided on program design, status and results to date.

Finally, the Regional Conservation Partnership Program, a new program under the 2014 Farm Bill that provides a great new opportunity for additional targeting of private lands conservation. Projects selected for funding will: 1) be solution and results oriented, leverage non-federal resources 2) promote leveraging of other Federal and non-federal resources, 3) be innovative and integrate multiple conservation approaches, and 4) seek to maximize the number of organizations that participate in and contribute to projects.

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LABYRINTHULA: AN OVERLOOKED AGENT OF GLOBAL SEAGRASS DECLINE AND POTENTIAL INHIBITOR OF SEAGRASS RESTORATION

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Seagrass ecosystems continue to decline at alarming rates around the world. Known to provide a variety of ecosystem functions and human services, seagrasses are a critical component of coastal marine ecosystems and their loss is concerning. Various methods for restoring and enhancing seagrass habitat following acute and chronic disturbances have shown to have limited success in some cases. The role of disease in the failure of seagrass restoration and conservation efforts is largely unknown.

Pathogens from the genus *Labyrinthula* are known to cause disease symptoms in a variety of seagrass species. Although difficult to culture and poorly characterized taxonomically, species of *Labyrinthula* are common in marine ecosystems. Virulence of genotypes/phylotypes is known to be variable, and highly virulent species are able to cause ecologically significant diseases. For example, the infamous global 'wasting disease' events of the seagrass *Zostera marina* in the 1930's, along with other localized events in the 1980's and 1990's, have been attributed to an epidemic disease caused by *Labyrinthula*. Recently, detailed studies of *Labyrinthula* infection in seagrasses of Puget Sound, Washington, United States of America and Central Coast, New South Wales, Australia point to the global significance of this poorly understood disease.

Unfortunately, efforts to map changes in the extent of known seagrass beds are often sporadic and long-term in-situ studies monitoring and surveying for the presence of disease are largely absent. Along with monitoring for known physical stressors, we argue that biological stressors of seagrass, including known seagrass pathogens, need to be better understood and assessed globally. Results from these investigations may improve restoration and conservation efforts by ecologists going forward. The implications of seagrass infection by *Labyrinthula* in a changing global climate are also significant and a discussion of key parameters and missing research is also included.

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ECOSYSTEM RESTORATION OVER SPACE AND TIME: AN EXAMPLE FROM THE RESTORATION OF LONGLEAF PINE SANDHILLS ON EGLIN AIR FORCE BASE, FLORIDA, USA

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The restoration and management of the longleaf pine ecosystem in the Southeast United States is a major focus of many federal and state agencies and conservation organizations, and is the primary goal of America's Longleaf Restoration Initiative. We review the recent history of restoring, managing, and management decision-making for the longleaf pine sandhills ecosystem on Eglin Air Force Base (EAFB), a 187,780 hectare military reservation in panhandle Florida, USA.

A primary objective of EAFB's adaptive management program is to actively restore the installation's longleaf pine sandhills. We review the development of a desired future condition for this ecological system, the establishment of long-term monitoring plots, and the development of two remote-sensed models for predicting the ecological condition of the longleaf system and prioritizing the annual implementation of fire management. We also review the results of an experimental study comparing the response of ground cover vegetation across three hardwood reduction treatments (midstory hardwood removal through herbicide application, mechanical removal, and fire only) in relation to control and reference conditions. The study was initiated in 1994 and first assessed in 1998. Study plots were resampled in 2010.

In addition to tracking the success of longleaf restoration on the installation, the results of these studies have shown that the reference sites on the base vary considerably over time. This has led to the development of the dynamic reference condition concept, a conceptual framework to better understand and integrate the range of spatial and temporal variation associated with the best available reference sites. We illustrate a practical tool for statistically defining reference sites and for measuring restoration success in continually changing conditions. The concept and methods should be widely applicable to other ecosystems and restoration goals.

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APPLICATIONS OF THE EVERGLADES DEPTH ESTIMATION NETWORK (EDEN) DATA AND TOOLS FOR ECOLOGICAL ASSESSMENTS IN THE EVERGLADES

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The Everglades Depth Estimation Network (EDEN) is an integrated network of water-level gages, interpolation models, and programs that estimates surfaces of daily water-levels and derived hydrologic data across the freshwater part of the greater Everglades landscape. The goal of the network is to provide consistent, documented, and readily accessible hydrologic and ground-elevation data for the Everglades. Prior to EDEN, ecologists and biologists assessing trophic- and landscape-level responses to hydrodynamic changes in the Everglades often estimated water levels from nearby gages or linearly interpolated water levels between gages. There was a need for a region-wide, high-resolution spatiotemporally continuous estimation of water level and water depth with on-line web access to these datasets. Target users of EDEN data and products include biologists, wildlife-resource scientists managing habitat requirements for endangered species, fire ecologists, and water-resource managers monitoring water levels and depth to meet mandated regulation schedules.

The EDEN surface-water model interpolates water-level data from a network of 240 gages to generate gridded daily water-level surfaces. When these surfaces are combined with EDEN's digital elevation model of the ground surface, derived hydrologic data provide scientists and water managers working in the Everglades with data necessary to analyze ecological and biotic responses to hydrologic changes in the Everglades. Derived datasets include water depth, recession rates, days since last dry (water levels below ground surface), water-surface slopes, and hydroperiod.

Three applications of EDEN-modeled water-level surfaces and other EDEN datasets demonstrate how scientists and resource managers are using EDEN data for ecological assessments in the Everglades. One application correlated EDEN-simulated water levels with body condition data for alligators. Results of this application show how water depth affects animal condition in timeframes as short as 90 days. In the another application, scientists who study foraging behaviors of wading birds in wetland habitats used change in hydrology as a surrogate for habitat and food availability. In the third application, EDEN water-level and ground-elevation data were used to document the influence of hydrology on post-fire landscape dynamics. These applications highlight how water management practices can affect the health and sustainability of the flora and fauna of the Everglades.

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REAL-TIME REPORTING OF INUNDATION ON TREE ISLANDS IN THE FLORIDA EVERGLADES

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Tree islands in the Florida Everglades are important ecological and cultural resources that are affected by changing water levels. They are topographic high points which are periodically wet, support woody vegetation (trees and shrubs), and are surrounded by predominantly sawgrass wetlands with water depths less than 2 meters throughout most of the year. Tree islands provide food, shelter, and habitat for many flora and fauna in the Everglades, such as nesting sites for wading birds, and forage areas and dry refuge for white-tailed deer. Archeological investigations have revealed how pre-Columbian cultures used tree islands extensively for habitation, resource procurement, and burial sites. Local Native American tribes continue to use the tree islands as cultural and sacred burial sites.

Natural flow patterns in the Everglades have been modified by Federally-mandated water-control plans that strive to regulate water levels for wildlife resource management and for flood management in the surrounding urban areas. In the regulated parts of the Everglades, northern areas dry out more frequently than non-regulated areas of the natural system whereas areas upstream of levees that compartmentalize the Everglades wetlands pond water for much of the year. When a new water-control plan was instituted in 2012 as a part of the Comprehensive Everglades Restoration Plan, State and Federal agencies needed a real-time reporting tool for monitoring water levels at tree islands in the impact area.

The Everglades Depth Estimation Network (EDEN), initiated in 2006, is an integrated network of real-time water-level gages, interpolation models, and web-accessible applications that generate daily water-level maps and derived hydrologic data for the freshwater part of the greater Everglades. The EDEN was updated to report inundation at about 400 tree islands in Water Conservation Areas 3A and 3B, and Everglades National Park. The maximum ground elevation at each tree island is compared with the daily water level modeled by EDEN to determine if the tree island has been overtopped, or inundated. An automated email is sent to stakeholders to report tree islands that have been inundated each day. The EDEN website provides users with access to a map of the impact area where tree islands are color-coded for the status of inundation on a daily basis. Both the automated email to stakeholders and the EDEN website serve as real-time reporting tools for inundation of tree islands in the Everglades.

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LIFE TO AD(D)MIRE; MIRERESTORATIONS IN SWEDEN

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The Life to ad(d)mire project will restore 35 Natura2000 sites from the North to the South of Sweden. The project aims at stopping the decrease of habitats and species at these sites through hydrological restoration and vegetation measures.

The ditches draining the mires are filled to restore the hydrology; most of these restorations are done by excavators. Peat is used for filling the ditches and logs are used as plugs to stabilize the structure. In other parts of the mires the ditches are given a more natural appearance by meandering morphology.

Specific foci or data or policies?
The specific foci of this presentation are practical measures of wetland and river restorations in Sweden. The county of administrative board of Jämtland in Sweden have been restoring rivers and wetlands 15 years. The measures used for these restorations have differed throughout the years, the results are both good and better than good.

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FUNCTIONAL FOREST OR GREEN DESERT: IS DURBAN'S FLAGSHIP REFORESTATION PROJECT MEETING STATED TARGETS?

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The City of Durban (South Africa) is restoring indigenous forest and woodland ecosystems, in the 800 ha buffer zone, surrounding the Buffelsdraai Regional Landfill site. The Buffelsdraai Landfill Community Reforestation Project (BLCRP) initially aimed to offset a proportion of CO_2 emissions, generated locally, during the 2010 FIFA World Cup™. However, the project's mitigation function has now been superseded by a climate change adaptation focus. The need to improve the City's resilience, in the face of increased uncertainty and risk, is considered urgent. Building functional ecological infrastructure, which includes indigenous forest ecosystems, can help bolster such resilience. The involvement of local impoverished communities, in the building of new forests, further strengthens the resilience objective, through local poverty alleviation and skills development.

This paper examines the extent to which tree species composition, measures of diversity, and functional traits of restoration sites, are comparable with a local forest reference site. After 3-5 years, restored sites show low similarity with reference forests due to different species composition and poor diversity. 40 tree species were recorded in the reference ecosystem, while restored sites averaged only 28 species. Tree density in the study site is also considerably lower than figures suggested for restored forests.

The above findings suggest that the project will not meet stated targets, and it is recommended that restoration activities be altered, in order to realign the current trajectory. Addressing these concerns could include, for example, ensuring a broader suite of propagated species, and higher densities of planting. This would ensure enhanced biodiversity, and increased canopy closure. The many pioneer tree species already planted on site would provide a better micro-environment for supplemental planting of additional climax species. Critically, improved and continuous monitoring over the coming years is required, in order to elucidate appropriate management responses.

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TOPOGRAPHIC DIVERSITY INDEX FOR FLOODPLAIN FOREST RESTORATION BENEFIT ASSESSMENT AT HURON ISLAND, UPPER MISSISSIPPI RIVER

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The Upper Mississippi River System (UMRS) was transformed from a free-flowing, floodplain river to a shallow draft navigation system in 1940 with the implementation of 30 low head dams comprising the 9-Foot Channel Project. Impoundment effects on surface water distribution are most pronounced at each dam and diminish upstream. The influence on groundwater is similar. Change in aquatic area following impoundment included loss of nearly all sand bars and mudflats in the active channel and conversion of low elevation floodplain forest to impounded and backwater aquatic habitat. High elevation floodplain forests were transformed by a perched water table that stressed intolerant species and changed forest structure.

In the Iowa River Reach where Huron Island is located the number of island-side channel complexes was reduced from 12 to only 6 in 70 years. Large island-side channel complexes are important because they were an integral part of the aquatic and bottomland forest communities in the riparian corridor along the length of the river. Islands in particular were dynamic environments supporting high forest diversity.

Island topographic diversity is important because different plant communities occur within specific flood zones, and lack of physical diversity can lead to low plant community diversity as has been seen in large rivers nation-wide. The Topographic Diversity Index (TDI) was developed to estimate the relative area of the Huron Island project site within specific flood zones and compare them among several hydrologic/physical reference conditions. It is an integrated GIS mapping and hydrologic analysis that incorporates input from digital elevation maps and river stage frequency analyses to estimate the terrestrial area that occurs within specific flood zones. The benefit metric is acres within specific flood zones that are relevant to the survival and distribution of tree species. The TDI allows sensitivity analysis or scenario testing to estimate benefits of different restoration and management alternatives.

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EVALUATING EFFECTS OF ACTIONS ACROSS A RANGE OF UNCERTAINTY: APPROACHES TO EVIDENCE ASSESSMENT IN THE MISSOURI RIVER RECOVERY PROGRAM

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The Missouri River Recovery Program has been conducting an analysis of the effects of river management and restoration actions on the populations of three federally listed species: the piping plover (*Charadrius melodus*), the interior population of the least tern (*Sternula antillarum*), and the pallid sturgeon (*Scaphirhynchus albus*). The objective of the effects analysis (EA) is to assess the overall effects of particular actions and to develop numerical models to predict effects of management alternatives, as part of a broad adaptive management planning process. While the overall objective of the assessment is the same for all three listed species, considerable differences in the types and amount of uncertainty for each species has led to different approaches for assessing and synthesizing evidence. The comparison of these differing approaches in the context of a common river system and management objective may be useful for managers and researchers developing approaches for evidence-based evaluation.

The understanding of piping plover dynamics is characterized by low structural uncertainty and moderate parametric uncertainty. Their demographics have been relatively well studied; their response to management actions can be directly observed given sufficient monitoring resources; and several population viability models have been published. Identifying critical hypotheses and information gaps for piping plovers is relatively straightforward. *What* is needed for plover population viability is generally understood; the primary question is *how* best to measure and optimize restoration activity. For the plover EA, we have focused on synthesizing best available science and improving predictive models. In contrast, the EA for pallid sturgeon has been faced with much higher structural uncertainty and complexity as well as high parametric uncertainty. A number of hypotheses exist about the critical needs of pallid sturgeon, but the rarity of the fish and its occupancy of deep, turbid water makes direct observation of the effects of management on critical life stages difficult or impossible. Moreover, there is a paucity of data for modeling those critical life stages. Consequently, the pallid sturgeon EA has required more time developing and refining complex conceptual models and identifying priority hypotheses in order to address the question of *what* is needed before rigorously addressing *how* to achieve those objectives. In between these cases lies the EA for the least tern, which has been less studied than the piping plover and for which the effects of habitat change and management actions are less apparent. Nevertheless, neither the structural nor parametric uncertainty is as high as that of pallid sturgeon. The EA approach for terns has been similar to that of plovers, yet must address the management implications of higher uncertainty. We will present a comparison of evidence available for these three species to illustrate how structural and parametric uncertainties influence the present state of decision making for Missouri River Recovery.

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HOW DO RESTORATION SITE CHARACTERISTICS, PLANT CAGING, AND PARENTAL SOURCE AFFECT NATIVE PACIFIC CORDGRASS ESTABLISHMENT?

W. J. Thornton *and K.E. Boyer*

Olofson Environmental Inc: State Coastal Conservancy San Francisco Estuary Invasive Spartina Project, , Oakland, California, USA

A key programmatic goal of the San Francisco Estuary Invasive Spartina Project's restoration program is to reestablish native Pacific cordgrass (Spartina foliosa). This foundation species provides critical habitat to the endangered California clapper rail and offers important ecosystem functioning. Five large scale experiments conducted from 2010-2013 have tested how restoration site characteristics, plant caging, and parental source of S. foliosa transplants have effected establishment rates of native cordgrass. Throughout all experiments, outplanting location (e.g., geographic location, substrate, elevation) and caging were strong predictors of planting success. Establishment rate of native cordgrass was highest on uniform mudflats and wide channel banks (62%) with lower establishment rates occurring in 2nd order channels and bayfront habitat (15%). Cage effects varied by marsh, with the strongest cage effects occurring at sites with nesting Canada goose (7% survivorship in uncaged plots, 78% survivorship in caged plots). In a separate experiment, parental source was a strong predictor of planting establishment. Plants were collected from eight widespread marshes, genetically tested using microsatellites, and grown in identical nursery conditions. After 10 months, source populations differed in terms of culm height and density. Following nursery growth, 300 plants from each donor source were outplanted into two marshes and monitored quarterly. Sources varied significantly in terms of survivorship, flower production, and culm density. Field performance was not predictable from nursery bed performance. Successful restoration of native cordgrass requires understanding site specific conditions including marsh hydrology, elevation, substrate, and herbivores. Continuing research will determine long term effects of transplant source.

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THE GULF COASTAL PLAINS & OZARKS LANDSCAPE CONSERVATION COOPERATIVE: DEFINING DESIRED ECOLOGICAL STATES TO GUIDE RESTORATION AND CONSERVATION

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There are twenty-two Landscape Conservation Cooperatives across the United States that also reach into Canada and Mexico. This network of cooperatives were set up to define, design and deliver landscapes capable of sustaining natural and cultural resources in the face of such threats and stressors as climate change, population growth, and urbanization. This is a cooperative effort between non-governmental organizations, federal and state agencies. The Gulf Coastal Plains & Ozarks Landscape Conservation Cooperative (GCPO LCC) provides scientific and technical support, coordination, and communication to the conservation community and fosters cooperative capacity and facilitates the refinement of that purpose through targeted monitoring, evaluation, and adaptation over time.

Within the GCPO LCC, the Adaptation Science Management Team has developed a Science Agenda that outlines the partnership's approach to planning and design. Relying on the principles of Strategic Habitat Conservation, this group of 40 scientists and managers has identified priority habitat types for each of the 5 major subgeographies within the LCC and then defined species and landscape endpoints that describe desired ecological states for each of those habitat types.

Landscape endpoints reflect the appropriate amount, configuration, and condition of individual habitat types. Configuration describes broad-scale patterns of habitat structure (e.g., patch size, distance to edge, interspersion, connectivity, etc.); condition describes site-scale patterns of structure (e.g., basal area, canopy cover, etc.) and composition (e.g., oak vs. pine, etc.). Species limited by habitat characteristics reflective of these desired states are also identified to establish a set of habitat- and species-based conservation targets for each habitat type.

These desired states allow managers to evaluate the current status of their habitat types and identify appropriate management actions to take to achieve ecologically desirable outcomes. By ensuring alignment between habitat- and species-based conservation targets, the partnerships seeks to provide managers a means to translate their habitat management efforts into the currency of an individual species' biological response (i.e., change in abundance, occurrence, survival, etc.).

This presentation will outline not only the desired ecological states for bottomland hardwoods and open pine systems but also the collaborative process used to establish these desired ecological states as examples of the work being pursued for all habitat types within the GCPO LCC geography.

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RESTORATION AT THE LANDSCAPE SCALE, SWEETWATER MITIGATION BANK, NORTHWEST FLORIDA, USA

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The 864 acre Sweetwater Wetland Mitigation Bank was established in northwest Florida, as part of the regional general permit process. The bank sells credits to offset wetland impacts in a service area that encompasses a large portion of the Gulf Coast Flatwoods Ecoregion in the St. Andrews Bay Watershed. Restoration of the ecological structure and function to appropriate native plant communities and hydrologic restoration are accomplished through changes in dominant vegetation and lifeform, road and ditch removal, construction or re-creation of surface water flowpaths, seeding, planting and re-introduction of frequent fire regimes. The physical and ecological setting is best described as a mosaic of nearly level flatwoods, gently sloping seepage wetlands and depressional bogs and basin swamps. Landscape scale management began in September 2010 with a site wide timber harvest that reduced the slash pine plantation canopy to less than 100 trees per acre. The early phase of restoration that followed the timber harvest consisted of road removal and hydrologic restoration. Sheet flow in the nearly level landscapes and stream flow in the mildly dissected gently sloping landscapes were re-established as old roads were graded, culverts were replaced by low water crossings and ditches were filled. Following hydrologic restoration, fire was introduced to control woody shrubs and reduce the thick fibrous root mat that inhibited germination of native species from the seedbank. Aggressive woody shrub growth in the fire suppressed landscape has been treated by prescribed fire, roller chopping in 2013, and herbicide application in 2014. Although trending towards success, management of woody shrubs in landscapes that historically resembled open prairie and re-establishment of wiregrass (*Aristida stricta*) are the primary challenges to accomplishing the goals of the mitigation bank restoration plan. Restoration goals are measured by plant community assessment, hydrology and hydric soils. Assessment data is summarized to illustrate ecological trends in the landscape and provide direction for adaptive management strategies.

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LANDSCAPE CONSERVATION DESIGN AND STATEWIDE SEA LEVEL RISE AND URBANIZATION SCENARIOS FOR THE PENINSULAR FLORIDA LCC

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There are twenty-two Landscape Conservation Cooperatives across the United States that also reach into Canada and Mexico. This network of cooperatives were set up to define, design and deliver landscapes capable of sustaining natural and cultural resources in the face of such threats and stressors as climate change, population growth, and urbanization. This is a cooperative effort between non-governmental organizations, federal and state agencies. The Landscape Conservation Cooperatives (LCCs) have been charged with conservation design for each of their prospective regions.

In 2013, the PFLCC Science Committee undertook a set of measures to coordinate and combine previously-separate conservation support efforts. Researchers from the University of Florida and the Florida Natural Areas Inventory are providing new analyses and updates on statewide conservation priorities, sea level rise, and storm surge threats. These parameters are being integrated by GeoAdapyive Inc. and Geodesign Inc. into comprehensive statewide scenarios which include simulation of potential future urban development, climate change, shifts in planning approaches and regulations, and variations in financial resources. Three future time horizons were simulated for each scenario: 2020, 2040 and 2060. Each Alternative Future visualizes land use patterns and landscape transformations such as coastal inundation, urbanization, and infrastructure changes. Future changes in conservation lands are modeled and/or designed based on the input from local experts and managers and using the best available ecological information and data. The resultant scenarios are then to be handed off to USGS scientists, who are building a conservation spatial decision visualization tool which will provide interactive access to the results. This scenario-based research investigation aims to better illustrate the challenges and helps managers understand the cumulative impacts of possible decisions across a range of scales, while enabling them to identify partnerships they may need to better prepare for future conservation challenges.

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BENEFICIAL REUSE OF DREDGED MATERIAL – THE SAN FRANCISCO BAY EXPERIENCE

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The dredging community in San Francisco (SF) Bay has successfully partnered with restoration agencies over the past 12+ years, and made significant strides in beneficially reusing material dredged from Federal and private navigation channels. The Long Term Management Strategy for Dredged Material in SF Bay (LTMS) is a joint initiative of federal and state government that is involved in dredging and dredged material disposal. The goals of the LTMS are to reduce unconfined aquatic disposal of material within SF Bay, encourage beneficial re-use of dredged material for marsh restoration and other uses, and to facilitate a coordinated regulatory structure for testing of sediments and for obtaining permits. The framework has been in place since 2000, and at the recent 12-year review milestone, the LTMS agencies recommended that the basic program, which calls for approximately 80 percent of dredged sediment to be targeted for beneficial reuse or out-of-Bay disposal and only 20 percent targeted for in-Bay disposal, continue into the future.

The LTMS process has already resulted in substantial restoration of wetlands in SF Bay including: Hamilton Wetlands (over 700 acres of former diked lands utilizing about 6 million cubic yards of dredged material), which is a joint project between the USACE and theCalifornia State Coastal Conservancy; Montezuma Wetlands (over 1800 aces in construction), which is a private enterprise that will beneficially reuse about 20 million cubic yards; Bair Island (over 30 acres of former diked lands utilizing about 300,000 cubic yards of material).

Without these projects, it would have been difficult to dredge the Federal channels in SF Bay. The intent is for beneficial reuse sites, such as those above and others like it in SF Bay, to become the primary placement locations for federal and local navigation dredging projects.

In addition to the constructed projects, planning efforts are substantially underway to reuse most of the clean maintenance dredged material that comes from Federal and private navigation channels in SF Bay. This includes the South Bay Salt Pond (SBSP) Restoration Project which seeks to restore up to 15,000 acres of former salt ponds to wildlife habitat, provide public access, and provide flood protection features. A Beneficial Reuse Plan is currently being prepared to opportunistically receive material from dredging as well as upland projects in the area for habitat creation and flood protection. In light of the subsided elevation of the ponds, projected sea-level rise, potential for reduced suspended sediment concentrations in the Bay, and the desire for broad upland transition zones, beneficial reuse of material has been identified to be very desirable.

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SUSTAINABLY BUILDING WETLANDS WITH RIVER SEDIMENT:THE MISSISSIPPI RIVER LONG DISTANCE SEDIMENT PIPELINE

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Wetland loss in coastal Louisiana is a significant and urgent problem. Loss estimates are roughly a football field an hour. The restoration and sustainability of the wetlands depends on the re-introduction of sediment into the marshes. Historically sediment was delivered to the wetlands though the annual cycle of river flooding. With the construction of flood protection levees, this pathway was lost. The Mississippi River still represents the largest sustainable source of sediment to rebuild and maintain coastal Louisiana wetlands. Two key strategies exist to address these large scale losses: the reintroduction of river sediment through diversions to restore natural pathways and deltaic processes or the dredging and transport of sediment from the river to areas of critical need through the use of pipelines.

The use of diversions to reintroduce sediment takes time. In areas of strategic importance or critical need the rapid loss of wetlands require the implementation of aggressive restoration strategies to get sediment back to the marshes. The Mississippi River Long Distance Sediment Pipeline (LDSP) project is just such an approach to supply large quantities of Mississippi River sediment to areas miles into the basin. This allows for the placement of river sediment back into the system at key locations rather than unsustainable redistribution of existing sediments within the basin. The LDSP project includes the construction of a reusable 13 mile pipeline corridor into Barataria basin along with the construction of hundreds of acres of marsh. LDSP and the Bayou Dupont Marsh and Ridge Creation project were bid and are being built at the same time using the pipeline for efficiency. In total this project will dredge over 7 million cubic yards from the river. The corridor provides the opportunity to synergistically construct multiple projects along a common alignment with a single sediment delivery system with significant potential savings in overall construction costs compared to individual projects.

While the LDSP project does not restore the natural cycle of sediment deposition from seasonal floodwater flow, it does provide a mechanism to achieve a similar result by transporting sediment from the Mississippi River to the coastal wetland ecosystems presently cut off by levees. Using sediment dredged from renewable borrow areas within the river allows for more aggressive restoration time scales than the sediment diversion pathways.

The locating of renewable borrow sites within the river through to the placement of sediment at the end of the pipeline and the innovations, opportunities, and constraints will be discussed along with the associated design, permitting, and construction challenges. Refill rates of borrow sites In addition, to the technical aspects, the interaction of stakeholders, environmental, regulatory, and landowner concerns had to be addressed to result in a successful project. The project is currently under construction and will be complete in late 2015.

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ECOLOGICAL RESTORATION OF BLACK OAK SAVANNAS AND SAND PRAIRIES INSIDE A STEEL MILL: ARCELORMITTAL BURNS HARBOR

Marcy Twete
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First certified by the Wildlife Habitat Council in 2013, ArcelorMittal Burns Harbor's Corporate Lands for Learning initiative utilizes unique site features to provide an array of conservation education opportunities for employees and members of the greater community.

A premier integrated steelmaking facility located in Burns Harbor, Ind., along the southern tip of Lake Michigan, ArcelorMittal Burns Harbor, hosts vital Indiana Dunes habitats, which provide a perfect setting for employees to learn about ecological restoration and enhancement projects under way at their workplace. Partnering with the Wildlife Habitat Council, American Heart Association, Shirley Heinze Land Trust, Dunes Environmental Learning Center, Indiana Department of Natural Resources and others, ArcelorMittal is restoring acres of black oak savannas and sand prairie habitats to host a high level of biodiversity. The restoration of Lake Michigan dune ecosystems is one example of how our company engages employees and community stakeholders in the critical ecological restoration and reclamation of our working lands. Now celebrating its 50th anniversary, this very unique steelmaking facility is proof that industry and nature can co-exist.

ArcelorMittal is the world's leading steel and mining company. Guided by a philosophy to produce safe, sustainable steel, it is the leading supplier of quality steel products in all major markets including automotive, construction, household appliances and packaging. ArcelorMittal is present in more than 60 countries and has an industrial footprint in over 20 countries.

Investing in our people; making steel more sustainable; enriching our communities; and transparent governance are principles that play an important role in all the markets where we operate. ArcelorMittal contributes to the development of strong and sustainable local communities by leveraging resources and technical support towards ecological restoration of lands and waters. We do this by being sensitive to local cultures, issues and priorities, by engaging with our communities in an open and transparent way, and by working in partnership with local conservation organizations and government agencies.

My presentation will describe several scales of community engagement and resources toward the restoration and management of Great Lakes Ecosystems and the Upper Mississippi Basin. From a regional public-private partnership working to restore the health, vitality and accessibility of the waterways in the Chicago and Calumet region called the Chi-Cal Rivers Fund to the Sustain Our Great Lakes Program, ArcelorMittal is restoring, protecting and preserving the fragile habitats and ecosystems that form the world's largest freshwater system.

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RESTORATION PLANNING FOR THE BRADDOCK BAY COASTAL WETLAND OF LAKE ONTARIO

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Braddock Bay is a coastal embayment on Lake Ontario consisting of over 340 acres of wetland and is located 11.5 miles northwest of Rochester, NY. Large coastal wetland ecosystems, like Braddock Bay have become scarce on the southern Lake Ontario shoreline as a result of urban and sub-urban development and shoreline hardening. Anthropogenic activity in the region has indirectly impacted Braddock Bay wetlands through erosion and loss of vegetative diversity. Through the EPA administered Great Lakes Restoration Initiative (GLRI), the U.S. Army Corps of Engineers (USACE), Buffalo District led a study to investigate potential opportunities to restore ecologic character of Braddock Bay.

Braddock Bay is part of a state wildlife management area and is located within the boundary of the Rochester Embayment Area of Concern (AOC), a geographic area prioritized for environmental remediation and improvement by the bi-national Great Lakes Water Quality Agreement. As a result of these designations, planning of the project required significant stakeholder engagement and coordination with the local remedial action committee governing remediation of the AOC.

Expansion of cattail monocultures has greatly reduced the vegetative and habitat diversity of Braddock Bay wetlands and reduced suitability for wildlife, including the state-endangered black tern, which has not nested in the bay since 1998. Erosion is also a major stressor to Braddock Bay wetlands. Retreat of the land spits and barrier beach that historically enclosed the bay began in the late 1800s and gradually exposed the interior wetlands to the high wave energy of the open lake resulting over 100 acres of emergent wetland loss between 1902 and 2005.

The Corps, in coordination with EPA, New York State Department of Environmental Conservation, the State University of New York, Brockport, and other Federal, state and local experts, investigated a variety of measures for restoring habitat diversity and reducing erosion of Braddock Bay wetlands. Cost effectiveness and incremental cost analysis were used in the comparison of habitat outputs between potential plans. The selected plan involves the combination of both structural and non-structural measures to restore wetland diversity and reduce erosion of emergent wetlands.

If implemented, this project could restore and protect a 340-acre wetland complex, contribute to improvement of a Great Lakes Area of Concern, and create habitat suitable for a state endangered species.

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ESTIMATING ECOSYSTEM CARBON STOCKS AT REDWOOD NATIONAL AND STATE PARKS USING INVENTORY AND FIRE EFFECTS MONITORING DATA

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Accounting for ecosystem carbon is increasingly important for park managers. We present our efforts to estimate carbon stocks and the effects of management on carbon stocks for Redwood National and State Parks in northern California. Using currently available information, we estimate that on average these parks' soils contain approximately 89 tons of carbon per acre (200 Mg C per ha), while vegetation contains about 130 tons C per acre (300 Mg C per ha). Restoration activities at the parks (logging-road removal, second-growth forest management) were shown to initially reduce ecosystem carbon, but may provide for enhanced ecosystem carbon storage over the long term. We highlight currently available tools that could be used to estimate ecosystem carbon stocks at other forested areas.

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WETLAND BIODIVERSITY RESTORATION IN AN ABANDONED SUGARCANE CULTIVATION SITE IN PUERTO RICO

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Native to tropical Asia, sugarcane (*Saccharum* spp.) was brought by Columbus to Hispaniola in 1493 as one of the earliest agricultural ventures of the New World. In 1509 Juan Ponce de León established the first agriculture experiment station of the Western Hemisphere in Puerto Rico on the Río de la Plata valley to develop crop cultivation techniques, including sugarcane. As a result of centuries of sugarcane cultivation coastal wetlands in many Caribbean islands, including Puerto Rico, were greatly reduced in area and quality. We implemented wetland restoration practices in abandoned sugarcane fields at the Humacao Nature Reserve in southeastern Puerto Rico. We evaluated the effects of soil and hydrological manipulations on vegetation, invertebrates and birds. We collected monthly data on vegetation, invertebrate, water depth, and salinity, and conducted weekly bird surveys.

Avian diversity increased from 16 upland-dominated species to 67 wetland-de pendent species. Among the waterbirds colonizing the restored wetlands were species of conservation concern such as the Bahama Pintail (*Anas bahamensis*) and West Indian Whistling Duck (*Dendrocygna arborea*). Moreover, rare species such as the Yellow-breasted Crake (*Porzana flaviventer*) used restored wetlands for nesting and foraging. Overall, water depths of 10-20 cm and salinity below 15 ppt promoted the establishment of wetland associated plants and invertebrates. Vegetative cover did not affect bird abundance, but it decreased bird species diversity and richness. Our results suggest management of water levels and vegetation manipulation was responsible for most waterbird species detected. Furthermore, observed responses by plants, invertebrates and birds suggests manipulative restoration practices may represent an alternative to improve wetland biodiversity in abandoned sugarcane fields. Particularly as many Caribbean islands have experienced marked declines of the sugar industry. Finally, wetland restoration at the Humacao Nature Reserve enhanced the recreational value of this protected area (i.e., birding) and facilitated the establishment of community operated ecotourism ventures.

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ACCOMPLISHING SUSTAINABILITY IN OUR URBAN ECOLOGY THROUGH PLANNING, MAINTENANCE AND RESTORATION AND ASSISTING COMMUNITIES WITH CREATIVE FUNDING STRATEGIES

Keith Villere
Villere Town Planning, Covington, Louisiana, USA

With roots stretching back to the invention of the automobile, Urban Sprawl accelerated its march across America after World War II aided by transportation improvements and advent of assistance on single family home mortgages. This spread was even further intensified with cheap fuel and the development of auto oriented establishments that caters to the driving population along with the advent of big box retailers. City centers were abandoned as the population moved outward creating in search of cheap land. The effect on urban and community forestry and urban ecosystems has created a myriad of problems including improper sewerage treatment and pollution of water bodies through non-point source pollution.

The cost of sprawl cannot be minimized and is aggravated by a dumb-growth cycle of development. Municipal costs to provide infrastructure and safety to these suburban residents is mounting with every new greenfield that is gobbled up for the pursuit of the American dream and the strip commercial development that it supports.

There are options available. Planning options including Context Sensitive Design and Smart Codes can provide a more sustainable future and preserve those natural features that are so important to the human habitat. Development's impacts can be minimized with thoughtful planning to protect and rebuild sensitive urban ecosystems.

Urban storm water runoff and floodplain management of our streams and wetlands can be enhanced using new technology that will create a more sustainable future that is consistent with the desires of the population it serves. Creative funding solutions can assist to plan for this more sustainable future.

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10 YEARS OF STREAM BANK MONITORING IN METRO ATLANTA

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Sediment is the single most important water quality problem and the largest contributor by volume of non-point source pollution in the U.S. Knowing the rates and sources of sediment is important information when planning a program to improve the water quality conditions within a watershed.

Gwinnett County, Georgia, located in the urbanizing Piedmont area northeast of Atlanta, has experienced increased stream erosion and sedimentation problems, which may be attributed to rapid urbanization of the area. In 2000, the Gwinnett County Department of Water Resources (DWR) completed a Watershed Protection Plan (WPP) in accordance with Georgia Environmental Protection Division (EPD) permitting requirements for a new or expanded wastewater National Pollutant Discharge Elimination System (NPDES) discharge permit (Gwinnett County 2000). During development of the WPP, Gwinnett County identified a target goal of total suspended solids (TSS) which related to a benthic macro-invertebrate score of "good".

To provide information regarding the amounts of stream sediment, the County initiated a stream erosion monitoring program in 2004 with the establishment of 50 monitoring sites. The primary means of monitoring is through bank pins in both the left and right banks of each of the 50 stations. In addition, a range of site characteristics are collected including cross section geometry and Rosgen classification. Since 2005 each of the 50 stations has been monitored on an annual basis. The upcoming 2014 monitoring will provide a total of 10 years of data.

Given the large data set spanning both wet, dry and average rainfall years the County has been able to develop a long term average erosion rate. This supports modeling that County has done as a part of watershed improvement planning. In addition, interesting relationships have been observed between the annual rate of erosion and precipitation.

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INFLUENCE OF THE MAJOR DRAINAGES TO THE MISSISSIPPI RIVER AND IMPLICATIONS FOR SYSTEM LEVEL MANAGEMENT

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The Mississippi River runs approximately 3,770 km from its headwaters at Lake Itasca, Minnesota, to the Gulf of Mexico. The Mississippi River drainage basin spans all or parts of 31 U.S. states and two Canadian Provinces. With a total area of approximately 3,220,000 km^2, it covers 41% of the continental United States. The Mississippi River Basin (MRB) is typically divided into six or seven sub-basins, each defined by the watersheds of its primary tributaries: the Missouri, Ohio, Arkansas and Red Rivers, and the watersheds of the divisions of its main course: the Upper, Middle and Lower Mississippi River (often the Upper and Middle divisions are combined into one).

These sub-basins are quite diverse in terms of size, geology, geography, climate, land use and water management practices. This leads to disproportionate contributions of water, sediment and nutrients from each sub-basin to the total loads of these important constituents in the main stem of the Mississippi River measured below all of the input locations. For example, records from 1973-1994 reveal that the Missouri watershed, which is the largest of the sub-basins, delivered the highest load of suspended sediments, while the Ohio watershed, which is considerably smaller, delivered the largest load of water. Analysis of longer time periods reveal that nutrient loading is variable and dominant watershed inputs have shifted due to human induced changes in different sub-basins, mainly for agricultural purposes. Other research has shown that implementation of water control methods, mainly the installation of dams along principal tributaries, have substantially reduced the total input of sediment from the sub-basins to the main stem of the Mississippi River over the past two centuries. Future changes in climate and other important divers such as socio-economics have the potential to impact land use and water management practices in the major sub-basins, thus altering the total and proportional loading of water, sediment and nutrients to the main stem from these individual watersheds.

Utilization of Mississippi River sediment and freshwater resources are a cornerstone of the 2012 Louisiana Comprehensive Master Plan for a Sustainable Coast. The plan calls for diversions of mainly freshwater as well as diversions aimed at capturing the highest loads of sediment to promote deltaic land building along with dedicated dredging of the river bed for land creation. For these projects to implemented and operated with the greatest degree of efficiency and highest probability for success requires precise knowledge of current status and accurate prediction of future trends of water, sediment and nutrient input from the major sub-basins. These restoration projects must be balanced with navigation and flood control projects along the Mississippi River which are also sensitive to the dynamic nature of the MRB. This can only be accomplished through continued and applied research of water, sediment and nutrient input of the major sub-basins.

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APPLYING A COMMON ADAPTIVE MANAGEMENT FRAMEWORK TO CHINOOK AND ECOSYSTEM RECOVERY IN PUGET SOUND

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The Puget Sound Partnership is a state agency serving as the backbone organization for Puget Sound recovery. It is also a designated National Estuary Program and a Regional Recovery Organization for the coordination of salmon recovery efforts in Puget Sound. The Puget Sound Partnership (PSP) is working with the Puget Sound Chinook salmon recovery Lead Entities to develop 16 watershed-scale monitoring and adaptive management frameworks for Chinook salmon recovery, translating local watershed approaches to recovery into a common regional framework. This presentation will discuss the process being applied to Chinook recovery, draft products from the watersheds and potential application for overall Puget Sound ecosystem recovery.

Using the *Open Standards for the Practice of Conservation* (*Open Standards)* to guide the process and the technical manual "Puget Sound Chinook Salmon Recovery: A Framework for the Development of Monitoring and Adaptive Management Plans" (draft released by the Recovery Implementation Technical Team in 2013) as the technical basis for characterizing and monitoring ecosystem health, PSP is working with a team of consultants as well as scientists and policy-makers in each of 16 watersheds around Puget Sound to translate existing watershed plans into a common language. Watershed teams are capturing strengths and gaps in existing plans, assessing status and trends of Chinook populations and key habitat components, identifying status and effectiveness monitoring priorities, and documenting adaptive management processes to support use of new information to guide decisions on management and capital expenditures. This project forms the basis of an adaptive management system for Chinook salmon recovery in Puget Sound: it will establish a comprehensive, methodical, effective, and transparent monitoring and adaptive management program for salmon recovery that is incorporated into, and leveraged by, the broader efforts around Puget Sound recovery.

Based on the outcomes of applying this approach to Chinook recovery, PSP will evaluate potential application of a similar approach for steelhead recovery planning and comprehensive ecosystem recovery planning with the local integrating organizations (LIOs). This *Open Standards*-based approach may support prioritizing strategies and actions at the Action Area and LIO level, regional monitoring of status and effectiveness of Near Term Actions (NTAs) included in the Action Agenda, the roadmap for Puget Sound recovery, and may also support assessment of which NTAs are likely to be most effective toward meeting our recovery goals.

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EAU GALLIE RIVER AND ELBOW CREEK MUCK DREDGING AND ENVIRONMENTAL RESTORATION, MELBOURNE, FLORIDA

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At the behest of the St. Johns River Water Management District, in coordination with the City of Melbourne and with the support of the Florida Inland Navigation District, Taylor Engineering Inc., developed a conceptual plan, feasibility study, and supporting detailed cost estimates to dredge a deep layer of muck deposits that covers the bottom of the Eau Gallie River and Elbow Creek in Brevard County.

This thick muck layer creates shoreline water depths too shallow for boaters to navigate without disturbing the muck sediments. Suspended muck sediments cause several undesirable consequences. These include the deterioration of water quality and the covering of seagrass beds, the creation of anoxic benthic (bottom) conditions negatively impacting the lagoon's infaunal communities and the basis of the aquatic ecosystem food chain, the creation of malodorous and aesthetically displeasing black plumes of muck, and damage to boat motor cooling systems from muck entrained in outboard engines. Due to both its hydrology and physiography, deeper portions of the Indian River Lagoon and areas near tributaries or estuaries often collect significant quantities of nutrient-rich, fine-grained, organic muck sediments. Muck covers as much as 10% of the Indian River Lagoon bottom. The Eau Gallie River and Elbow Creek, tributaries of the Indian River Lagoon, also suffer these undesirable consequences.

Both the Indian River Lagoon Comprehensive Conservation and Management Plan (CCMP) and the Indian River Lagoon Surface Water Improvement and Management Plan (SWIM) recommend removal of these nutrient-rich, fine-grained, organic muck sediments within these water bodies as an efficient means to improve water quality and natural resources within the overall Indian River Lagoon. The Florida Department of Environmental Protection (FDEP) also endorses the removal of muck sediments under its Total Maximum Daily Loads (TMDL) program to remove the legacy loads of nutrients and pollutants associated with re-suspended muck sediments into the water column and the transport of muck into the Indian River Lagoon, negatively affecting seagrasses.

As a remedy to the Eau Gallie River and Elbow Creek sedimentation problems, which affect water quality in both the Eau Gallie River and Elbow Creek and likewise contribute to shoaling in the Indian River Lagoon and Intracoastal Waterway, the SJRWMD has proposed dredging nearly 625,000 cubic yards of muck sediment as an environmental restoration project. Taylor Engineering also factored in the project maintenance dredging interval and order of magnitude maintenance cost estimates into this feasibility study.

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EVOLVING REFERENCE SYSTEMS FOR LONGLEAF PINE ECOSYSTEM RESTORATION

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The use of an ecological reference is central to both restoration practice and science. Traditionally, a reference site that could be visited, described, and monitored provided information. Reference information evolved from descriptive metrics of extant reference sites, to include a variety of information about contemporary and historical conditions, and significantly to account for the variability associated with a single site through time, that is, the historical (or natural) range of variation (HRV). Recognizing that ecosystem variability is driven by variation in ecological processes challenged the prevailing concept and lead to considerations of "reference dynamics". Thus, the reference concept has evolved from a static model to one which incorporates ecological interactions, temporal and spatial variability and stochastic processes.

Despite a long history of research in the longleaf pine ecosystem, research directed toward understanding ecosystem function and variation within this extensive system continues. Research efforts, in longleaf pine and other systems, have also advanced approaches to describing and incorporating reference information into restoration efforts. In this paper, we review recent findings and approaches, and suggest how they may be incorporated into management decisions. In particular we highlight the findings and insights gained from our own field experiment designed to elucidate the factors that may limit restoration success.

We conducted work on Savannah River Site (GA), Fort Bragg (NC), and Fort Stewart (GA). Sample plots were selected to represent the range of upland conditions in the Atlantic coastal plain, and to include the range of disturbance history defined by three axes of variation: land use history, fire history, and canopy density. In 232 plots we measured species abundance and structure and environmental variables, and used structural equation modeling to investigate the multiple factors controlling species diversity in longleaf communities. Results both reinforce previous assumptions and increase understanding of factors that control diversity in degraded and reference sites. Regression trees were used to tease apart the roles of fire history, land use history, and canopy abundance in driving current vegetation structure and composition. Our data set allowed us to compare results from different locations, revealing both similarities and differences among locations. We interpret and illustrate the results focusing on their use as integral components of a broader ecological reference system that can inform management decisions.

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OYSTER REEF RESTORATION IN AREAS WITH SIGNIFICANT BOATING ACTIVITY

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By looking at changes in oyster reef coverage (number of reefs, acreage) on an approximately decadal basis since 1943, we have documented significant declines of oysters within Mosquito Lagoon, Florida, with the most serious losses occurring within the boundaries of Canaveral National Seashore (CANA). For Mosquito Lagoon, the number of reefs has declined from 2722 to 2542 (7% loss) during this period. More significant is the loss of acreage from 151 to 115 acres (24% loss). CANA had 576 oyster reefs in 1943 compared to 524 today (9% loss) with a 40% reduction in acreage over this time period (59 acres reduced to 36 acres).

Mosquito Lagoon is one of a handful of locations in the USA where losses are less than 50%, making restoration possible from the natural larval pool. In the shallow waters of Mosquito Lagoon, you can observe piles of bleached white, disarticulated shells above mean high water where live reefs were historically located. These piles are often dead margins on the seaward edges of oyster reefs, which we now know frequently turn into dead reefs within a few years. Once oyster clusters and disarticulated shells begin to accumulate above the intertidal zone on top of a live reef, most likely as a result of boat wakes, any stranded live oysters die and the shells bury the live oysters beneath it. The dead margin next migrates toward shore (mean rate in Mosquito Lagoon: 1.3 m/yr) covering over additional live oysters. Eventually only dead shells remain (= dead reef) and this continues to migrate shoreward until all shells wash up into the marsh and no intertidal reef footprint remains. Terrestrial plants frequently are found growing on dead margins/reefs. All (100%) of dead margins/reefs were located in boating channels.

Oyster reef restoration began in 2007 in Mosquito Lagoon. As of August 2013, 63 reefs (restoration footprint: 1.77 acres) have been restored by UCF/Brevard Zoo/TNC by over 34,000 community volunteers. The number of reefs restored each year varied depending on the dimensions of the dead reef/margin pre-restoration; this dictates how much loose shell material needed to be covered by stabilized shell (oyster restoration mats). The mats on the restored reefs are maintaining their structure and are not being dislodged by boat wakes. Analysis of the monitoring data over the past six years shows that, to date, our methodology that couples dead margin leveling with placement of oyster mats on the leveled shell material is exceeding all of our structural and functional monitoring objectives. On restored reefs: 1) no dead margins have reformed, 2) recruitment on 2007 mats continues to increase and is now an average of 118.1 per mat (0.25 m^2), and 3) seagrass recruited seaward of 37% of the restored reefs. If you multiply the mean recruitment value for 2007 reefs by the number of mats deployed, we have the potential to restore over 4.15 million oysters to the waters of Mosquito Lagoon. Overall, our project has been exceptionally successful in terms of oyster recruitment, habitat improvement, and community engagement.

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LANDSCAPE EFFECT OF MISSISSIPPI RIVER DIVERSIONS ON SOIL ORGANIC CARBON SEQUESTRATION IN LOUISIANA DELTAIC WETLANDS

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Large proposed water and sediment diversions are a central element of Louisiana's 2012 Coastal Master Plan to alleviate the high rate of coastal wetland loss in Louisiana. These large diversions affect salinity, nutrient availability, and the water quality of sediment-receiving wetlands, and can influence the composition, distribution and productivity of vegetation communities and soil biogeochemical conditions. Large diversions are therefore expected to affect the soil organic carbon (SOC) sequestration capacities of Louisiana coastal wetlands. However, little is known about the effect of Mississippi River (MR) diversions on SOC sequestration in the receiving wetlands under future environmental conditions. Eustatic sea-level rise (ESLR) and land subsidence are predicted to have significant negative impacts on coastal Louisiana and will increase the cost and reduce the benefit of diversions.

In this study, we predicted the impacts of MR diversions on basin-wide SOC sequestration rates for the next 50 years (2010-2060) under two scenarios (moderate and less optimistic) with regard to ESLR, subsidence and other environmental factors. Our analyses were based on model simulations of eight individual diversion projects within the Barataria and Breton Sound Basins using a wetland morphology model that was developed for Louisiana's 2012 Coastal Master Plan. Specifically, we examined the impacts of diversion discharge rates and the location of these individual diversion projects on SOC sequestration rates.

Model results indicate that basin-wide SOC sequestration rates tend to increase with diversions operating at small to medium flow rates, but decrease from medium to large rates. The thresholds of diversion discharge rates to achieve optimal rates of carbon sequestration depend upon basin characteristics and future environmental conditions. Location effects of diversions on soil carbon sequestration tend to vary with rates of discharge and basin characteristics. Within the Barataria Basin, a medium scale diversion when placed in the upper receiving basin tends to produce elevated SOC sequestration rates compared to those in the lower receiving basin. In contrast, at Breton Sound Basin, the optimal rate of SOC sequestration can be reached when placing a large scale diversion in the lower basin rather than in the upper basin. Our results suggest that MR diversion placement and operations should consider not only land building but also optimizing carbon sequestration in order to mitigate wetland loss and enhance the ecosystem service of greenhouse gas regulation provided by coastal wetlands.

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GULF COAST VULNERABILITY ASSESSMENT: AN APPROACH TO ASSESS KEY DRIVERS OF ECOLOGICAL CHANGE IN GULF OF MEXICO ECOSYSTEM AND SPECIES

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Good conservation and restoration planning requires mechanistic understanding of ecosystem and species vulnerability to predicted climate change, sea level rise and land use change. The Gulf Coast Vulnerability Assessment (GCVA) is a Gulf-wide initiative being developed under the authority of the Gulf Coast Prairie, Gulf Coastal Plains and Ozarks, South Atlantic and Peninsular Florida Landscape Conservation Cooperatives (LCCs), National Oceanic and Atmospheric Administration (NOAA) and Gulf of Mexico Alliance (GOMA). The GCVA is led by a Core Planning Team of federal and state agencies and non-governmental organizations.

The goal of the GCVA is to enhance conservation and restoration by providing a better understanding of the effects of climate change, sea level rise and land use change on Gulf of Mexico coastal ecosystems and species that they support. To reach this goal, a report will be developed and made available to conservation partners and policy makers to help advance collaborative science, science support and science project implementation.
The GCVA will provide information needed to identify opportunities to restore functional ecosystems and create adaptation strategies across the Gulf Coast.

Methods used to assess vulnerable species and ecosystems include conceptual ecosystem models (CEMs) that describe key drivers of ecological change and help identify conservation targets. Conservation targets are being identified through a matrix of biological and social attributes and climate experts are helping inform vulnerabilities of species and habitats based on a suite of different anthropogenic and climate change scenarios.

This presentation will outline the processes developed by the partnership to advance conservation and restoration planning and implementation in the Gulf of Mexico network.

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INCORPORATING COASTAL ENGINEERING PRINCIPLES IN THE DESIGN, IMPLEMENTATION AND MONITORING OF LIVING SHORELINES

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A living shoreline may best be described as a natural approach to bank and shoreline stabilization that uses plants, sand, and some rock to protect the shoreline while maintaining valuable habitat. Living shorelines often incorporate structural and organic materials to facilitate natural shoreline processes while providing shore- and marine-based habitat; stone, sand fill, reefs, and vegetation are commonly used to achieve these goals. While the terminology is relatively new, coastal engineers have for many years used the living shoreline approach, particularly for smaller projects along sheltered shorelines. In recent years, however, the living shoreline concept has focused more on coastal ecology than it has on addressing the local wave, tide, and sand transport environment—the physical coastal processes—and the requisite coastal engineering design needed to ensure continuity of the physical processes and ecological benefits. This trend is likely a combination of the growing popularity of living shorelines, the lack of widely available coastal engineering guidance on their design, and the design of living shorelines by non-engineers. Additionally, the professional practice and research communities of coastal ecology and coastal engineering have intersected on relatively few occasions. If successful alternatives to building bulkheads, revetments, and seawalls will ever flourish, these two areas of practice and research must make concerted efforts to collaborate on maximizing ecological and engineering benefits on a site-specific basis. This presentation will highlight existing living shoreline guidance and outline some best practices for the design, permitting, construction, and monitoring of living shorelines. Specific case studies will be used to demonstrate these concepts.

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PORT ALTO BEACH WETLAND RESTORATION AND CONSERVATION PROJECT

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In 2012 and 2013 Atkins provided a coastal engineering study, design engineering, and construction management for a project to restore a beach protecting a wetland and bird habitat in Port Alto, Texas. The constructed project was designed to protect over 10 acres of tidal coastal marsh and restore and enhance the habitats of the coastal environment. The project design implemented a sustainable solution to provide a living shoreline.

Port Alto is located in Calhoun County, Texas about 100 miles southwest of Houston. In 2012 Atkins prepared a shoreline access plan for Calhoun County and the Port Alto Beach and Wetland Restoration and Conservation Project was a direct outgrowth of this plan. Port Alto is located on the west side of Carancahua Bay and the beach is located to the North of the community. The wetlands area is about 10.3 acres in size and is protected on the east and north by a strip of beach, see Figure 2. The beach is "L" shaped with the longest leg about 1,200 feet in length.

Prior to construction, the project site consisted of a low lying beach under continuous erosional pressure by high-frequency wave conditions and intense wave energy during elevated storm tides, with various types of debris and detritus placed pall-mall along the shoreline in an attempt to protect the severely eroding shore face. Without action, it was apparent that the beach would quickly breach and the protected wetlands area would be exposed directly to wave and storm effects. Atkins partnered with Calhoun County to perform a coastal engineering analysis of the area and develop options for continued protection of the wetlands area and sustainability of the shoreline as a barrier to wave forces and maintain its appeal as a recreation destination in south central Texas.

The design recommended to the county included beach nourishment, construction of two rock groins, and construction of two break- water reefs off the eastern portion of the beach. The purpose of the rock groins is make sand movement along the beach more difficult and the break-water reefs purpose is to absorb wave energy before the wave impacts the beach. Removing energy from the wave helps sand to remain in place on the beach.

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COASTWIDE REFERENCE MONITORING SYSTEM-*WETLANDS*: PROVIDING DATA FOR LOUISIANA'S RESTORATION AND PROTECTION PROGRAMS

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The Coastwide Reference Monitoring System-*Wetlands* (CRMS) is a state/federal partnership funded by the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) and the State of Louisiana to monitor the effectiveness of individual restoration projects and the cumulative effects of the restoration program. CWPPRA has constructed more than 100 restoration projects using a variety of construction methods since its authorization in 1990. Construction of 390 monitoring sites, begun in 2005, was completed in 2007. Monitoring sites are located on private, federal, and state lands across Louisiana's coastal zone and are visited on a monthly basis to collect hydrologic and soils data, twice annually to collect elevation change data, and once per year for vegetation data. Aerial photography is collected approximately every three years for land/water analysis.

All data and products are available to the public and restoration professionals through a public website operated and maintained by USGS and CPRA (http://www.lacoast.gov/crms). Feedback from the CWPPRA sponsors on utility of data summaries, visualizations, and improvements to tools are solicited annually and incorporated into the website. The CRMS analytical teams, consisting of scientists and information technology specialists, used ecological monitoring variables to create a Floristic Quality Index (FQI) for emergent marsh, a Forested FQI (FFQI) for forested wetlands, a Hydrologic Index (HI), and a Submergence Vulnerability Index (SVI). The CRMS report cards are available in real-time on the CRMS website and are generated "on-the-fly" so that assessments are based on the most current data. The data and indices are used for ecological comparisons at the site, project, basin and coastwide scales. Monitoring reports produced on a three year rotation provide a more detailed evaluation of the performance of CWPPRA projects. This information is funneled back into the planning and design of future projects, is used to evaluate and adaptively manage constructed projects, and assist with close-out recommendations when the projects reach the year 20 life span.

While designed for CWPPRA, the comprehensive monitoring program's value extends to all restoration and protection programs, providing valuable information regarding wetland response to natural stressors such as drought, flooding, and tropical storms as well as manmade incidents.

These data are utilized to fill information gaps and refine hydrodynamic and ecological models developed as part of the state's Master Plan.

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ECONOMIC MODELING FOR EVERGLADES RESTORATION: A TEN-YEAR PERSPECTIVE

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The original driving motivation for the book, The Economics of Everglades Restoration: Missing Pieces in the Future of South Florida (Weisskoff, 2005), was the hypothesis that the relationship between the growing population, on the one hand, and society's need for water, on the other hand, would make Everglades restoration impossible. The sprawling cities on the fringes of the Everglades and the intense farming and ranching upstream from the Everglades would stress the natural system, drawdown the aquifers, and destroy the estuaries.

The hypothesis that restoration would be unlikely as long as the economy kept growing was tested statistically in the 2005 book by hybridizing two sophisticated regional economic modeling systems, REMI and IMPLAN, and then overlaying them with newly-constructed variables for agriculture, tourism, construction, and the expected spending of Everglades restoration (CERP).

In addition to the econometric modeling, The Economics of Everglades Restoration is a statistical encyclopedia of South Florida's economic growth, exploring the connection between economic variables ("driving forces"), wetland ecology, and the history of man-made structures that carved up South Florida's Everglades over the past century.

Then, after 50 years of spectacular growth, the South Florida economy crashed. This paper compares the original forecasts with the statistical record of today. We find our model to be resilient. For some counties and regions in South Florida, our forecasts were, understandably, optimistic. But in other counties, our population and water forecasts were right on target. Even in the former cases in which the original forecasts over-predicted water demand for 2010, the post-recovery trends are already indicating a "reversion" to the growth trajectory similar to that measured during the boom period. More encouraging is another measured trend in some of the largest counties: population growth has slowed and water consumption per capita has fallen dramatically. If these trends are sustained, Everglades restoration has a greater chance of success.
The 2005 book concluded with a series of "possible futures" and their impact on restoration. These vignettes too have turned out to be remarkably accurate. What were once "fantasies" are today seriously debated among decision-makers while other "fantasies" have become actual projects.

The paper concludes with a comparison of how the "possible outlook" of a decade ago has, in fact, become an operational path. Stakeholders are now aware how the economy can aid, rather than undermine, Everglades restoration.

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THE MISSISSIPPI RIVER: ON THE CUTTING EDGE OF PLACE-MAKING AND ADVANCED REGIONAL COLLABORATION IN THE U.S.

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The Mississippi River is quickly becoming the main-stage of advanced regional collaboration around place-making in the U.S. This process creates important trends for the policy-making process both at the state and national levels. More than 3 million residents populate the 124 Mississippi River main stem cities and towns. The Mississippi River Cities & Towns Initiative, comprised of 59 cities, gives a common voice to those who depend most upon the River, and by virtue of doing so, spans political and economic interests. The River is an important natural resource, and its health and vitality as an ecosystem is a bellwether to the prosperity of the Mississippi River Valley Corridor. These local leaders focus on how to best integrate transportation, farming, industrial, municipal and environmental interests to launch lasting solutions to River management issues. Discussion will include why this initiative was created, and how a local government-lead effort empowering the ten States and more than 100 cities that border the Mississippi River can act for their continued prosperity, sustainability, and economic growth. There will be specific focus on how restoration of the Mississippi waterway can best facilitate and actualize these goals. MRCTI is dedicated in using a collaborative method to find impactful, lasting solutions which incorporate the best environmental and economic practices to create a sound and healthy region.

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GETTING TO THE ROOTS OF SUCCESSFUL COASTAL BALDCYPRESS RESTORATION

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The search for effective means to restore coastal freshwater baldcypress (*Taxodium distichum*) swamps has challenged scientists, resource managers and lay people alike for several decades. In southeastern Louisiana, regionally rapid rates of wetland loss and sea level rise have spurred interest in better understanding what biological and environmental factors constrain effective cypress restoration. Based on common garden field trials and greenhouse experiments, I evaluate the importance of genetic variation, restoration site substrate characteristics, and horticultural nurturing practices on the growth and survivorship of baldcypress seedlings and saplings. In addition to analyzing variation in baldcypress performance in all of these studies, I propose a suite of guidelines for practitioners engaging coastal baldcypress restoration. In 2007 and 2008 our collaborative team established four baldcypress restoration sites in present day marshes (formerly baldcypress swamps) adjacent to the estuarine Lake Pontchartrain, and at one site in the Bonnet Carré Spillway (a freshwater diversion of the Mississippi River used only at crisis river flood times). Employing a factorial design, we contrasted performance of saplings differing in genetic background and in the size of their root system at outplanting, among sites differing in pore water salinity. We measure survivorship and height growth twice annually, and we observe site porewater salinity occasionally. In addition to interannual variation in weather conditions, this trial has experienced two sustained openings of the Bonnet Carré Spillway (2008 and 2011) and a few significant tropical storm/hurricane storm surges.

Since 2007, we have observed unusually high baldcypress sapling survivorship rates in the field trial (all sites >50%, as high as 90%) despite soil pore water salinity measurements at some sites in the 4-7 ppt range, integrated over the 0-50 cm soil depth interval, a salinity level that kills cypress seedlings. Survivorship of saplings planted with intact root systems – in either one gallon or one pint containers – greatly exceeds that of bare root saplings, especially during the first year. Survivorship differences between saplings initially raised in different soil volumes is more complex, as are performance differences among half-sib groups. Site location (and probably site conditions) influences seedling response to each of these main factors.

Implications: Concern about sustaining and restoring coastal baldcypress swamps is longstanding and widespread. Much effort has been directed toward restoration efforts, most of which have employed bare root stock planted without physical protection from mammalian herbivores. Typically restoration managers also are unaware of the genetic source of the cypress stock they plant. Recruitment rates of baldcypress in these restoration projects have been low. Very few of these efforts have combined rigorous scientific design or evaluation with practical resource management goals. As we move forward with extensive restoration plantings across a wide variety of site conditions, we face an urgent need for intensive assessment of factors likely to influence coastal baldcypress restoration success. To be effective stewards, we need evaluative guidelines linking baldcypress performance to suites of co-existing stressors.

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MIGRATING BIRD USE OF BRACKISH MARSHES: DOES RESTORATION TECHNIQUE MATTER?

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An important goal of coastal wetland restoration, particularly from the public perspective, is to rehabilitate impacted wildlife populations, including migratory and resident birds. If successful, such restoration projects will revitalize migratory flyways for waterfowl (ducks) and shorebirds by providing trophic support and roosting habitat. There are many different approaches to wetland restoration, including variations in construction technique and planting strategy. *Engineered* marshes are often constructed by placing soil in terrace or mound formations, creating aquatic habitat that can be used by waterfowl. In contrast, *beneficial uses (BUDM)* marshes are created by depositing dredge material to fill continuous areas to emergent marsh elevation. Neither the *engineering* nor the *BUDM* approaches explicitly incorporates mudflat habitat, despite its importance for the charismatic shorebirds that are iconic coastal wetland species. Mudflat habitat may be created in *BUDM* areas by reducing or delaying marsh planting.

We investigated how these varied restoration techniques altered migratory and wintering bird usage of restored brackish marshes in the J. D. Murphree Wildlife Management Area near Port Arthur, TX (USA). Our research addressed two questions: (1) What is the value of restored brackish marshes to migrating birds? (2) Does bird density and species composition differ among marsh restoration techniques? We deployed time-lapse game cameras for two-week periods in fall 2013 and winter 2014 in a native undisturbed marsh and two constructed marshes, one with engineered mounds and the other an unplanted poured dredge slurry. We assessed bird utilization of the restored brackish marshes by comparing the frequency of bird presence and bird species richness among habitat types. Shorebirds and waterfowl preferred the less vegetated restored marshes, relative to the heavily vegetated native marsh. Of the two constructed marsh types, there was a higher abundance of birds in the *BUDM* marsh than in the marsh with engineered mounds. However, there were different species of waterfowl, wading and shorebirds utilizing each restored marsh type. For instance, *Eudocimus albus* (white ibis) and *Limnodromus* sp. (dowitcher) were more commonly seen along the edges of the engineered mounds, whereas *Himantopus mexicanus* (black-necked stilts) and *Anas* discors (blue-winged teal) utilized the *BUDM* marsh. These data will inform management decisions by showing that an ideal restoration design incorporates both aquatic and mudflat habitats which can be utilized by various species of waterfowl and shorebirds.

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ENVIRONMENTAL CONSTRAINTS ON THE RESTORATION SUCCESS OF BLACK MANGROVE HABITATS IN THE NORTHERN GULF OF MEXICO

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Black mangrove (*Avicennia germinans* (L.) L.) occurs at its North American latitudinal limit within coastal salt marshes of Louisiana, USA, where further expansion is believed to be limited by the occurrence of periods of freezing temperatures. Black mangrove is often considered a desirable component of the target plant community at salt marsh restoration and creation projects within its range. Establishment success of any plant species is greatly enhanced when a thorough knowledge of the species tolerance limits to key environmental factors is available to guide project design. When black mangrove is included in coastal salt marsh creation projects in Louisiana, containerized, greenhouse-grown seedlings are often used as the planting unit, which can be costly on a large scale. Black mangrove propagules, or young seedlings, may represent a less expensive restoration method, particularly on a coast subject to periodic freezing episodes, which can damage or kill the mangroves depending on the severity of the event. To increase our understanding of factors that may influence black mangrove restoration success, we investigated potential differences in the tolerance of black mangrove life history stages to low temperature and environmental stressors that may be present at restoration sites.

Our research indicates that life history stages ranging from dispersal stage (propagules floating in salt water) to stranded stage and seedling stage all display similar tolerance to cold temperatures. However, freezing events of -6.5 C for 24 hours were most detrimental, particularly to stranded propagules which suffered considerable tissue damage and subsequent fungal infestation. Interestingly, dispersal stage propagules were least affected by freezing temperatures, apparently because of insulation provided by frozen salt water.

A series of controlled experiments to determine black mangrove seedling tolerance to environmental stressors indicated that 6-month and 18-month old seedlings have similar tolerance to elevated substrate salinity levels, water table depth and hydrologic regime. An average water table depth of -15 cm to -30 cm below the soil surface appears optimal for above- and belowground production. Additionally, 24-month old seedlings displayed an asymptote of biomass and root:shoot ratio at 48 ppt. Elevation surveys confirmed that seedling transplant survival at restoration sites occurs within the same elevation range (hydrologic regime) where natural propagule establishment and adult trees are observed. We suggest that if a viable source of black mangrove propagules is present in an area, natural establishment of black mangrove may be possible. If a propagule source is limited, human-assisted dispersal of propagules into established salt marsh restoration sites may be a cost-efficient means of enhancing establishment of black mangrove when desired.

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THE GULF OF MEXICO RESEARCH INITIATIVE; A NEW RESEARCH PARADIGM

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The Gulf of Mexico Research Initiative (GoMRI) was established to guide and administer the $500 million research fund committed by BP to understand the fate and effects of the 2010 Deepwater Horizon oil spill. Competitive research awards are made by an independent research board led peer-review process following the standards established by the National Academy of Sciences and the National Science Foundation. The Board comprises twenty distinguished researchers with 10 members from around the world appointed by BP and 10 members from research universities in the Gulf region appointed by the Gulf of Mexico Alliance.

The two main goals of GoMRI are: 1) to study the Deepwater Horizon and similar incidents and their associated impacts on the environment and public health, and 2) to develop improvements for spill mitigation, oil detection and new remediation technologies. Through public input, GoMRI identified five research themes: 1) physical distribution of contaminants, 2) chemical evolution and biological degradation of contaminants, 3) environmental effects and ecosystem recovery, 4) technological developments and 5) public health impacts.

The largest pool of funds made available by the GoMRI to date was through RFP-I, released in April 2011, for consortia composed of at least four institutions to conduct interdisciplinary work on one or more of the research themes over a three-year period. GoMRI awarded $112.5 million to eight consortia for this three-year period. These awardees included experts from across the country, though most principal investigators were from Gulf States. Funds ($18.5 million) from a second RFP were awarded to nineteen, smaller, research teams at eighteen different institutions; contracted amounts range from $100,000 to $1 million per year for up to three years. The next major research competition is underway and the awards will be announced this coming fall.

GoMRI has created extensive data management and outreach programs. It established policies for timely submissions of data to existing national databases and a dedicated data discovery engine so data collected or generated will be available to all interested. Outreach efforts include consortia specific programs, an active central web portal for search of, access to and exchange of information, a centralized outreach program, and strategic partnerships with the Smithsonian Institution and Gulf of Mexico Sea Grant programs for outreach.

The GoMRI construct offers a new paradigm for the conduct of research.

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ECOLOGICAL ASSESSMENT OF RIPARIAN BUFFER STRUCTURE AND FUNCTION TO ASSESS ECOSYSTEM SERVICES

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Vegetated, riparian buffers enhance stream biodiversity and water quality by regulating inputs of light, organic matter, sediment and nutrients. The delivery of these ecosystem services is spatially explicit, however and may affect their associated societal value. This study examines stream biophysical parameters at sites along two streams (Branch Brook, Merriland River) in one southern Maine watershed that differ in riparian buffer quality (buffered versus open, designated as such apriori). To assess physical stream conditions at each site, in 2011, 2012, and 2013 we recorded water temperature, pH, specific conductance, dissolved oxygen, turbidity, NO^{3-}, percent aquatic vegetative cover, stream bed percent cover, substrates, stream width and depth, stream gradient, velocity, discharge, in-stream large woody debris, bank condition, spawning gravel areas and the locations of pools/riffles/runs and pool quality. To quantify buffer quality, we recorded stream bank percent vegetated cover, air temperature, canopy cover, and soil nutrients (NO^{3-} and NH^{4+} using resin bags). To characterize biotic communities in stream reaches, we measured epibenthic algae using tiles, macroinvertebrate species composition using rock collection bags, and fish composition, abundance, and biomass via electronic fishing techniques. Biotic indices, univariate and multivariate tests including PRIMER were used to compare biophysical conditions between buffer quality as well as streams across years.

Preliminary analyses of the first two years of data reveal no major differences by buffer type across years for any biophysical parameter measured. Rather, the greatest differences occurred between streams. Averaged across years, the Merriland River had significantly more large woody debris per reach, significantly less sand in its stream bed, and significantly more percent trees in its adjacent stream banks than Branch Brook. Biotic data show that both streams had comparable epibenthic algae and macroinvertebrate communities (as revealed by t-tests using indices of biological integrity (Rapid Bioassessment Protocol II)), though fish communities differed. Averaged across years, the Merriland River had significantly fewer fish, a significantly lower coldwater index of biological integrity, and significantly fewer brook trout (*Salvelinus fontinalis*) than Branch Brook. Together, these data suggest that differences in buffer quality are not as important as between stream differences in this southern Maine watershed. These ecological data may inform interpretations of residents' economic valuation of riparian habitats and their mental models of this important ecotone.

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DISCOVERY HILL OUTDOOR LEARNING CENTER: A PUBLIC DEMONSTRATION GARDEN USING RESTORATION PRINCIPLES

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The National Wildlife Federation (NWF), Austin Independent School District (AISD) and Environmental Survey Consulting (ESC) engaged in a collaborative effort to create a native plant area at the AISD Science and Health Resource Center in Austin, Texas. The goal was to use habitat restoration principles while creating a demonstration area for local teachers and students. A second goal was to encourage teachers to replicate similar native plant areas at their schools. Through grants from Toyota USA Foundation, 3M, H-E-B and Westcave Discovery Center, NWF provided the funding. AISD provided the space, and ESC provided the design and installation supervision. Material donations were provided by local business.

ESC created the design which included an annotated species list of approximately 190 native species to be used in the ¼ acre site. The design included areas representing different habitat niches, including open shrubs with flower edges, thickets, woodland, tall and short grasslands, wildflower meadow, ephemeral creek, succulent area, and freshwater pond. Concepts included techniques to harvest rainwater, effectively use stormwater run-off, control erosion through vegetative barriers and naturalistic terracing, and create companion planting of native species that mimic natural areas.

The garden was installed by ESC and over 75 community volunteers. Since completion, there have been several workshops at the site on identification of native plants, strategies and techniques for maintaining various plant types, and principles of habitat restoration.

This project is very public and well-used by teachers and students. It is AISD's first outdoor classroom and training site, and the first of its kind installed in Texas by the National Wildlife Federation. The garden offers a place for field investigations, a way to improve student performances in science and math, and opportunities for hands-on and inquiry-based experiences. All of these experiences are based on understanding the importance of the environment and habitat restoration.

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LEVEE BOARD'S PERSPECTIVE AND ROLE IN MISSISSIPPI RIVER DIVERSIONS

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The LaBranche wetlands in St Charles Parish, offer a localized example of the coastal wetland loss issues facing Louisiana. From 1932 to 2005 more than 6,500 acres of wetland loss have occurred with large areas becoming open water, with over 1,900 square miles lost coastwide over the same period. In particular, wetlands can form a protective apron in front of hurricane protection levees, provide a buffering against storm surge and waves that would otherwise impact the levee directly.

Combating land loss in coastal Louisiana requires a systematic approach employing multiple restoration tools, such as river diversions from the Lower Mississippi. Freshwater and sediment, valuable to the neighboring ecosystems, are confined to the leveed river until released through the passes where they are lost to the deep waters of the Gulf of Mexico. With the realization that the sediment starved deltaic basins to river's east and west are sinking and facing ever rising sea-levels, a cornerstone strategy of the State of Louisiana's Comprehensive Master Plan for a Sustainable Coast is re-connect the river to the delta plain and utilize the river's resources.

The State of Louisiana is designing and seeking permits for the construction of a project to divert Mississippi River water into the Maurepas Swamp. The construction of the diversion would require alteration of the existing east bank Mississippi River levee for which the Pontchartrain Levee District is responsible for operating and maintaining.

The Pontchartrain Levee District was created by the Louisiana Legislature in 1895 for the primary purpose of maintaining 115 miles of the levees along the east bank of the Mississippi River, with its role expanded in the 1980s to provide hurricane protection including the operation and maintenance of 10 miles of Hurricane Protection Levee in St. Charles Parish.

This session will present the Levee District's perspective and role concerning the implementation of the Maurepas Diversion, including the legal, policy, technical, scientific, environmental, socioeconomic, and stakeholder issues that the District must take into account. The presentation will address the impact to the District's operation and maintenance of the levees within their jurisdiction and interactions between the District and the various stakeholders, including the diversion applicant (State of Louisiana), USACE, non-governmental organizations (NGOs), landowners, and the District's constituents. Additionally, the potential to opportunistically use the Bonnet Carré spillway to divert freshwater, sediments and nutrients in to the Labranche and Frenier Wetlands, has been explored. This session will explore the logistical considerations and constraints to implementing an opportunistic use program, as well as proposing alternatives to such a program to address these constraints.

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ESTIMATING NATURAL HYDROLOGY AND SALINITY IN AN ALTERED ESTUARINE ECOSYSTEM: AN EXAMPLE FROM THE GREATER EVERGLADES, FLORIDA

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Worldwide, anthropogenic alteration of freshwater flow into coastal regions has heavily impacted estuarine and coastal ecosystems. Effective and sustainable restoration of these ecosystems is dependent on understanding the natural patterns of freshwater flow, and the relationships between influx of freshwater and salinity in the estuaries and coastal zones. For the Greater Everglades Ecosystem of south Florida, a requirement of the Comprehensive Everglades Restoration Plan that guides the 30-50 year effort is the establishment of salinity performance measures and targets for the estuaries. This requirement began a dialogue between scientists and managers that led to the development of a method for estimating natural hydrology and salinity, prior to the construction of canals and the onset of water management in mid-20th century.

The method is a 3-phase process that links paleoecologic information on salinity with linear regression models developed using observed hydrologic data (salinity, stage, flow). In the first phase, shallow sediment cores from Florida Bay are analyzed for molluscan faunal content. A statistical method similar to the modern analog approach is used to compare the faunal assemblages in the sediment core to salinity data on living mollusks. The result is a paleosalinity estimate for the segment of the core just prior to anthropogenic alteration (circa 1900 CE). This estimate is converted to a paleo-based salinity time series using model-based data. Phase 2 is the development of statistical models that enable the prediction of salinity, stage, and flow based on observed data. In the final phase, the paleo-based salinity time series replaces the observed salinity in the statistical models to estimate the flow and stage necessary to achieve the paleosalinity estimates. This process has been repeated for five cores with the results from each core weighted using the Mean Square Error Estimate (MSE), then the weighted results were combined. The results show that in the absence of water management, Florida Bay salinity would be approximately 3 to 9 practical salinity units lower than current conditions. In order to achieve these salinities, freshwater flow into the upstream marshes would need to be 2.1 to 3.7 times greater than existing flows and upstream stage would be approximately 0.25m higher than current conditions. The method illustrated here can be used by scientists and managers in any estuary with available or obtainable paleoecologic data and empirical or model based hydrologic data, in order to establish targets for effective and sustainable restoration of these altered systems.

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THE ROLE OF PALEOECOLOGY IN PLANNING FOR FUTURE MANAGEMENT SCENARIOS: EXAMPLES FROM THE GREATER EVERGLADES, FLORIDA

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Natural changes in ecosystems take place over many time scales from diurnal to millennial and longer. However, numerous studies have indicated that anthropogenic changes have altered these natural rates. In order to understand the significance of ecosystem changes documented during the last 20 to 50 years, it is essential to understand the longer-term natural patterns of change. Important questions for managers responsible for restoring ecosystems and planning for future sea level rise and climate change scenarios are: 1) How do current rates of ecosystem change differ from the past? 2) What is the trajectory of change? 3) What is the response of biota to changes in the physical environment (eg. temperature, salinity)? 4) What species are good indicators of change? These questions, and many others, can be addressed by examining the faunal and floral remains in sediment cores collected throughout the area being managed. Paleoecologic studies provide the means to examine ecosystems over centennial to millennial timescales, which are the appropriate temporal scales for analyzing ecosystem change. Under the optimal depositional conditions, sediment cores can provide a nearly continuous record that extends our understanding beyond the limits and the incomplete nature of existing scientific data. In addition, the paleoecologic data can be linked to short-term monitoring data, placing current ecological trends in the appropriate historical context.

Examples of the application of paleoecologic studies in addressing management questions are provided for the Greater Everglades Ecosystem. Restoration of the Everglades is planned as a 30 to 50 year effort, during which IPCC (Intergovernmental Panel on Climate Change) projections indicate continued changes in climate and sea level that will impact restoration efforts. Paleoecologic analyses of terrestrial plant communities in the Everglades wetlands highlighted vegetation change during the Medieval Warm Period (~900-1300 CE) and the Little Ice Age (~1300-1800 CE). In the nearshore transition zones of coasts and estuaries, faunal and floral patterns have demonstrated distinct shifts in communities that are potentially related to climate, sea level rise, anthropogenic alterations, or a combination of drivers. Analyses of estuarine cores have been used to develop estimates of salinity patterns prior to land use and hydrologic alterations to freshwater flow; these data have been used in statistical models to predict past freshwater stage and flow in the wetlands and to develop salinity targets. These and other examples illustrate the importance of understanding long-term patterns of change in ecosystems in order to make sustainable and cost-effective decisions about resource management.

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U.S. ARMY CORPS OF ENGINEERS PERSPECTIVE OF MISSISSIPPI RIVER DIVERSIONS

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Louisiana has lost about 1,900 square miles of its coastal wetlands since 1932, including approximately 17 square miles of coastal wetlands every year since 1985. Combating land loss in coastal Louisiana (which is due to multiple factors, including dredging canals for oil and gas exploration and pipelines, salt water intrusion, storm damage, river management, sea level rise, subsidence, and invasive species), requires a systematic approach employing multiple restoration tools, such as river diversions, headland and barrier island restorations, and marsh creations.

In 2013, the State of Louisiana submitted permit applications to USACE for two diversions on the lower Mississippi River: the Mid Barataria Diversion, and the Maurepas Diversion. Both of these diversions will require alternations to existing USACE projects and therefore, will require both a Department of the Army (DA) permit and approval under 33 USC Section 408 to alter an existing USACE project. In addition, the State has indicated their intent to pursue the implementation of several other Mississippi River diversions.

The lower Mississippi River and the Louisiana coastal area are utilized by many different groups and interests for diverse purposes. USACE must take into account these stakeholder views when evaluating lower Mississippi River diversion permits. There are numerous legal, policy, technical, scientific, environmental, socioeconomic, and stakeholder issues related to Mississippi River diversions that must be taken into account. In addition, in order to facilitate evaluation of permit applications and allow risk informed decisions concerning proposed river diversions, anticipated environmental impacts of the diversions on the Lower Mississippi River and the receiving areas, induced impacts of shoaling on proposed and existing projects, impacts to the Mississippi River levees, and potential induced flooding in developed areas must be adequately assess.

This session will present the USACE perspective and role concerning Lower Mississippi River diversions, including the status of evaluating the DA permit application and the Section 408 request for the Mid-Barataria and Maurepas diversions. In addition, the presentation will address diversion-related issues cited above, issues identified and/or resolved, and lessons learned to date, to inform future large coastal restoration actions.

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LIVING ON THE WATER'S EDGE - A NEIGHBORHOOD APPROACH TO STORMWATER MANAGMENT

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The Neighborhood Environmental Stewardship Team (NEST) concept promotes neighborhood involvement in environmentally friendly projects to protect and restore our water resources. The NEST program projects focus on providing watershed, stormwater and Low Impact Design (LID) education and getting neighbors involved in activities that improve their neighborhoods and enhance their watershed. The program's goal is to help citizens and neighborhoods become advocates and champions for the watersheds they live in. The NEST program was developed in response to a need to get citizens and the general public better educated and more involved in stormwater management and protection of the water resources of Sarasota County.

A NEST is a voluntary association of people, neighbors, civic groups, student organizations and others - who want to better understand and improve environmental conditions in their watershed and make their neighborhood a better place for people, wildlife and our water resources.

This presentation will discuss how NEST groups are completing projects to reduce the impact of stormwater run-off on our natural environment and improving the watershed by:

Creating native aquatic shoreline vegetative buffers in stormwater ponds and waterways to reduce bank erosion and nutrients and sediment entering our water bodies along with increased wildlife habitat.

Maintaining a 10 foot fertilizer-free vegetative low-maintenance zone around our wetlands, ponds, lakes and bays to help improve water quality.

Adopting LID techniques including rain water harvesting, rain gardens, bio-swales and pervious surfaces to utilize rainfall on site and reduce storm water run-off.

The NEST concept is now being evaluated for adoption by many other cities and counties within the State of Florida.

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EVALUATING THE EFFECTS OF VEGETATION RESTORATION IN DALING RIVER RIPARIAN ZONE

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Daling River located in the northeastern of China, the length of its main stream is 447 km. In the river channel, crop was the major vegetation before. Since the ecological restoration plan of returning farmland to grass implemented from 2010, 90% of riparian zone has been restored. The effect of vegetation restoration in riparian zone focuses on vegetation coverage, the subtractive effect of non-point sources contamination and river water quality improvement. The runoff of the first 10 years of the 21st century has been reduced 5.28 times to 1960s.And 3.28 times to 1990s. In 2010, 93% water function zones water quality is not up to standard. And the amount of fish species has been less about 1/3. From 2011 to 2013, there were 5 hydrological station's run-off, water quality, fish and benthos was monitored. There are 36% water function zones water quality has up to standard now. The vegetation coverage has up to 93%.Before 2014 autumn, the soil properties monitor plan will carry out. This plan wants to test different vegetation and different restore time the soil properties. The interesting results can presented to you in CEER July 2014.

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A CASE STUDY OF LANDSCAPE RECONSTRUCTION AND RESEARCH IN THE OIL SANDS: SYNCRUDE CANADA LTD.'S SANDHILL FEN WATERSHED PROGRAM

***Carla Wytrykush**, Jessica Clark, Marty Yarmuch, and Audrey Lanoue*
Syncrude Canada Ltd. Research and Development, Edmonton, AB, CA

Syncrude Canada Limited (SCL) is leading industry in closing knowledge gaps in tailings landform construction and reclamation practices for the oil sands industry. SCL has constructed the Sandhill Fen Watershed, a large scale (~50ha), research pilot project developed to improve tailings reclamation technology in the Athabasca Oil Sands Industry. The landform includes upland and wetland components, as well as infrastructure that supports a large inter-disciplinary, long-term research program. A key objective of the Sandhill Fen Watershed research program is to gain knowledge and provide guidance for future lease development and reclamation. Three key study areas include: understanding the nutrient, salt and water balances, landform design guidance, and wetland reclamation guidance. Research done on the Sandhill Fen watershed will lead to better reclamation practices and an increased ability to meet our closure commitments.

This presentation will highlight Syncrude Canada Ltd.'s watershed approach to research and planning, challenges associated with managing large scale, long-term interdisciplinary research programs, and strategies for disseminating research results into operational practice, using results from the Sandhill Fen Watershed program as a case study.

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NAVAJO AML RECLAMATION PROJECTS, NAVAJO NATION

Melvin H. Yazzie
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The Navajo Nation's Abandoned Mine Lands Reclamation Department (Navajo AML) has been implementing the provisions of the Department of Interior's (DOI) Surface Mining Control and Reclamation Act (SMCRA) of 1977. While the main emphasis of SMCRA is to address coal mines, our Department has been successful in addressing over 900 abandoned uranium mines at a cost of over $25 million. The Navajo Nation encompasses approximately 27,000 square miles in the states of New Mexico, Arizona and Utah.

Under this effort, Navajo AML has been able to perform reclamation efforts on abandoned mine lands (AML). These mines include a variety of surface and underground mine features along with a large amount of mine waste. The mines are a result of the United States need for uranium minerals for the war efforts dating back to the 1950-1970's. The remnants of these uranium mines have been left within the jurisdictional boundaries of the Navajo Nation with no responsible parties for reclamation.

Navajo AML has implemented an in-house Health Physics Program to ensure our employee and contractors safety while on the job. This program has also been important in our education in providing information on our reclamation efforts within the communities.

Reclamation efforts have been initiated to address the physical and some environmental related problems associated with these mines, hence ensuring public and environmental safety. Navajo AML has implemented new technology and designs that relates directly to on-the-ground stabilization of the terrain. These ideas lead to effective project management concepts and cost savings for the Navajo Nation.

These projects have led to numerous partnership opportunities that we have welcomed and pursued. Technology and Information transfer are concepts that have benefitted other local, tribal, state and federal agencies in understanding the Uranium Legacy on the Navajo Nation. These Partnerships have also exposed our program to other Regulatory Authorities. Our Geographic Information System (GIS) has been vital in documenting the location of these abandoned mine lands (AML). Our department has remained on the forefront with technology.

Lastly, our reclamation efforts have been performed under the laws and regulations of the Navajo Nation with a staff of Navajo Professionals from Engineers, Technicians, Computer Specialist, and Administrative staff. Navajo AML has been successful under the provisions of SMCRA in addressing some of the legacy of uranium mines on the Navajo Nation. We will continue *"Restoring Navajo Lands to Enhance Beauty, Harmony, and Quality of Life"* for our people.

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A FIRST IN THE CAPE FEAR RIVER - ENHANCING ANADROMOUS FISH SPAWNING HABITAT

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A primary goal of the Cape Fear River Partnership, developed by the National Oceanic Atmospheric Administration in 2011, is to restore and demonstrate the value of robust, productive, and self-sustaining stocks of migratory fish in the Cape Fear River. Building on the momentum of the newly constructed fish passage at Lock & Dam #1, this partnership of key federal, state, local, academic, and other organizations in the region is working together on a multi-year action plan. Using a broad range of tools and capabilities, we seek to provide long-term, habitat-based solutions for the most pressing challenges for migratory fish.

The Cape Fear River historically supported large runs of anadromous fish species, but population levels have declined substantially over the last two centuries. Reduced landings of anadromous species have been attributed to the same variety of anthropogenic stressors (e.g., overfishing, pollution, habitat degradation and dam construction) that have affected many other Atlantic coastal rivers. The most apparent of these stressors in the Cape Fear River is the presence of three low-head lock-and-dam structures constructed between 1915 and 1934 by the USACE for commercial navigation. As of March 2013, the USACE completed construction of a rock arch weir at Lock and Dam No. 1, allowing fish passage up to Lock and Dam No. 2. Considering the limited passage above Lock and Dam No. 2, spawning habitat enhancement downstream of Lock and Dam No. 2 will provide substrate to encourage successful spawning activity for American shad.

The Cape Fear River Fisheries Enhancement project includes the placement of approximately 1,000 tons of crushed granite rock for the purpose of restoring 0.5 acres of preferential American shad and sturgeon spawning habitat downstream of Lock and Dam 2. Downstream of Lock and Dam No. 2 was chosen due to existing hydraulics in which the turbulence from the Lock and Dam would keep stone placed clean and free of silt, which is a key element for spawning. Construction will take place in January 2014. The project will be completed utilizing a 56' spud barge (see image) with hydraulic ramp and excavator along with a small tug boat. Research has shown American shad and sturgeon are pelagic or semi-pelagic spawners and spawn over larger substrates, therefore this project proposes to utilize a mixture of gravel, cobble, and boulder size rock, primarily 2” to 12” size for gravel and cobble.

The Cape Fear River Fisheries Enhancement Project is the first of several habitat restoration projects planned for the Cape Fear River watershed. To ensure the proposed outcomes of the construction project (spawning of anadromous fish) have been met, active monitoring of spawning and egg production will be conducted to ensure the success of the proposed enhancement project.

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LIVING SHORELINES AND WAVE ATTENUATION DEVICES: A HYBRID DESIGN SYSTEM

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Superstorm Sandy revealed just how vulnerable our coastlines are to storm energies, increased storm frequencies, and sea level rise. Many of the so-called solutions use the word "resilience." However, to date there has been no consistent qualitative or quantitative definition applied to the term resilience. As such, expectations and goals tied to "resilience" have yet to be formulated; *efforts just need to be "resilient" regardless of what it means*. Superstorm Sandy made it abundantly clear that our natural systems tended to fare better than man-made features and structures. Therefore, most agree that a significant part of our coastal resiliency is directly tied to the preservation and protection of our natural areas. Unfortunately, our natural areas, including marshes, dunes, and beaches are also vulnerable, and are being lost the tune of more than 1 acre per day in some areas. If we attenuate the erosive energies contacting our coastlines, we could build in resilience by implementing living shorelines and protecting existing natural systems. Help may be available through the application of a Hybrid Energy Attenuation System, which is a multistep energy reduction system that takes advantage of natural processes and is supplemented with a structural, energy-attenuating, component. The cornerstone of the system is the initial energy attenuation that disperses the brunt of wave energies prior to contacting the coastline. This system transforms an area of higher erosion to an accretion zone. In addition, this system offers unprecedented resilience, and is a valuable tool to the coastal resilience toolbox.

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RESTORATION CHALLENGES AND SUCCESSES IN MEXICO: PLANNING, PARTNERSHIPS, AND COMMUNITY ENGAGEMENT

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In the last two decades, efforts to understand the impacts of Colorado River water management on the natural habitat in the Colorado River Delta have revealed significant restoration opportunities. Although less than 10% of original wetland area and less than 5% of cottonwood and willow forest remain in the Delta, small-scale restoration projects have been underway since 2002 to protect and enhance riparian and marsh habitat. However, scaling-up restoration efforts and securing water for instream flows in the Delta have proven to be politically challenging due to the Colorado River's transboundary nature. Restoration of the Delta requires not only a legal framework for transboundary water negotiations, but also the binational political and public support for restoration efforts.

Cross-border partnerships, collaborative research, successful pilot restoration projects, and local community engagement in Delta restoration activities have greatly increased support for restoration efforts. Through on-the-ground restoration projects, the Sonoran Institute and partner organization, Pronatura Noroeste, have demonstrated the feasibility and the ecological and economic benefits of restoration in the Delta. To date, they have restored over 150 acres of riparian habitat and created more than 500 acres of marsh wetlands. Additionally, over 10,000 people from local community groups, universities, and government agencies have participated in restoration activities, helping to foster long-term stewardship of restored areas. Lastly, binational partnerships between conservation organizations and government agencies at the local, state, and national levels have enabled the negotiation and implementation of innovative transboundary water policy.

As a result of these efforts, the U.S. and Mexico signed binational agreement Minute 319 in November 2012, which will expand restoration efforts and allocate water to the Delta for the first time in history. Over the next four years, 158,088 acre-feet of water will be dedicated to the Colorado River in Mexico for environmental purposes, and 2,300 acres of riparian habitat will be restored in the Colorado River Delta region. With the legal framework and binational partnerships in place, the next challenge will be to achieve the ambitious restoration goals of Minute 319. Sonoran Institute and partners are exploring diverse restoration techniques, including hydroseeding, to promote native riparian tree establishment through both natural germination and planting. In this presentation we will report on the success of these efforts and potential challenges in meeting restoration goals.

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MANAGING THE MULTI-AGENCY COLUMBIA ESTUARY ECOSYSTEM RESTORATION PROGRAM AND ASSISTING IN RECOVERY OF THREATENED AND ENDANGERED SPECIES

***Benjamin D. Zelinsky*[1]*, Blaine D. Ebberts*[2]*, and Lynne D. Kransow*[3]**

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Spawned from the multi-agency and multi-discipline Lower Columbia River and Estuary (LCRE) Cumulative Effects study, the Columbia Estuary Ecosystem Restoration Program (CEERP) was created to meet the estuary ecosystem restoration requirements of the Biological Opinion (BiOp) for the operation of the Federal Columbia River Power System (FCRPS). The CEERP has developed into a functional adaptively managed restoration program that provides substantial benefit to Endangered Species Act (ESA) recovery in the Pacific Northwest. A joint effort between the Bonneville Power Administration (BPA) and the U.S. Army Corps of Engineers, Portland District (Corps), CEERP engages state, federal, Tribal, and local entities in ecosystem restoration throughout the lower Columbia River and estuary.

Although benefiting endangered salmon is a primary driver, the objectives of the CEERP reflect an ecosystem-based approach: 1) Increase the opportunity for access by aquatic organisms to and for export of materials from shallow-water habitats; 2) Increase the capacity and quality of estuarine and tidal-fluvial ecosystems; 3) Improve ecosystem realized functions. The primary approaches to restoration are to restore hydrologic connections between main stem and floodplain, create and/or enhance shallow-water habitat, and reestablish native vegetation.

A major component of the CEERP is the analysis and rating of individual restoration projects by a panel of scientists known as the Expert Regional Technical Group (ERTG). The application of science through an adaptive management framework is essential to the ERTG process. The ERTG evaluates projects using a combination of professional judgment and best available science. This blended approach ensures that science is central in decision making while preventing imperfect knowledge from becoming an excuse for inaction.

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LOUISIANA'S MASTER PLAN FOR A SUSTAINABLE COAST: USING IRBM TO ASSIMILATE PRIORITIES OF MULTIPLE STAKEHOLDERS

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Louisiana's ongoing land loss crisis has already claimed 1,880 square miles of vegetated wetlands. One of the nation's largest environmental planning efforts, *Louisiana's Comprehensive Plan for a Sustainable Coas*t (2012 Coastal Master Plan) uses an integrated river basin management approach to significantly reduce the rate of future land loss and to increase flood protection for all coastal Louisiana citizens. The 2012 Coastal Master Plan developed a dramatically different approach through its science-based, comprehensive vision for the future. The two-year analysis was based on an integrated management approach led by some of the state's best scientists, national and international specialists, which also incorporated feedback from hundreds of local stakeholders. The state used this analysis to select 109 high performing projects that could deliver measurable benefits to our communities and coastal ecosystem over the coming decades. The plan shows that if these projects were fully funded at a price tag of $50 billion, we could reduce land loss and increase flood protection to create a more sustainable coast.

CPRA used state-of-the-art technical tools and an integrated modeling approach that put a premium on delivering results. Advanced analysis evaluated hundreds of projects in systems context in order to select those that provide the greatest return on investment, while considering both economic and environmental constraints. The linked models predicted change in the conditions of the Louisiana coastal system under two types of future management strategies: a future with and without the implementation of additional restoration and risk reduction projects. While the concept of linked models in Louisiana coastal planning is not new, the master plan substantially improved or developed entirely new feedbacks and links.

The 2012 Coastal Master Plan is founded both on rigorous science as well as the local knowledge and values of many diverse coastal citizens. Not simply soliciting public feedback on a finished product, CPRA created a platform for discussion among a range of divergent voices over the two-year plan development process through the Framework Development Team and Focus Groups. These stakeholder groups were heavily involved in establishing the plan's objectives as well as providing overall guidance to the planning process. The long-term dialogue between these groups and the planning team allowed members to build bridges back to their constituents not directly involved. The collaboration among diverse interests was critical to building greater understanding and public acceptance which ultimately led to the plan's unanimous passage by the Louisiana State Legislature.

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