

## **Managed Shoreline Retreat by Reconstruction of an Estuarine Beach at Aramburu Island, Richardson Bay**

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Estuarine beaches composed of coarse sediments (sand, shell fragments, gravel) were formerly widespread in Central San Francisco Bay, where they occupied a narrow upper intertidal zone between tidal flats and wave-cut scarps in salt marshes or uplands. Artificial bay mud levees and armored (riprap) shores have generally replaced estuarine beaches as the shoreline interface type between bay mudflats, marshes, and terrestrial lowlands. The Aramburu Island Habitat Enhancement project serves as a demonstration project for reconstructing estuarine beaches to manage wind-wave erosion of shorelines in public open space lands with habitat and recreational uses. This artificial island in Richardson Bay was constructed from hillslope fill and dredged Bay material in the 1960s, and over decades eroded continually by progressive retreat of an unstable, vertical wave-cut scarp. The Aramburu beach design was based on empirical data collected on beach slope, sediment size distribution, and fetch at reference beaches around San Francisco Bay. Three different beach design approaches were implemented to reflect different combinations of beach slope and grain size and material type. The beach was constructed in fall 2011 by (a) grading back the shoreline profile; (b) building low micro-groin features from small boulders and woody debris to provide low, partial barriers to longshore drift, and (c) depositing different mixtures of sand, gravel, cobble, and oyster shell hash along the reconstructed shoreline in ratios based upon estimated incident wave energy. Gravel, sand, and shell were thoroughly reworked by waves during the first series of high tides immediately following placement, forming a series of self-constructed berms and minor swash bars. Following multiple winter storms with southeasterly (maximum fetch) wave approach, the berm profile persisted. Initial results suggest that shoreline nourishment with coarse sediment, sized to match local wave energy, appears to be a feasible strategy for managing erosion in recreational or habitat-priority bayshores.

**Keywords:** shoreline erosion, shoreline retreat, beach restoration

**Poster Topic:** Sustainable Habitats and Ecosystems

## Predicting Impacts of Global Climate Change on Native and Invasive Submerged Aquatic Vegetation in the San Francisco Estuary

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Native submerged aquatic vegetation (SAV) provides refuge and nursery habitat for estuarine organisms. Native SAV faces several disturbances, including SAV introductions and a changing climate. In the San Francisco Bay and Sacramento-San Joaquin Delta (the Estuary), temperatures are predicted to rise by 2°C by 2090. Salinity levels are projected to rise due to salinity intrusion from sea-level rise and decreasing freshwater inputs. It is uncertain how the native SAV, *Stuckenia filiformis* (fineleaf pondweed), will interact with the dominant SAV invader, *Egeria densa* (Brazilian waterweed), as temperatures and salinities change. Through a series of mesocosm experiments, we are evaluating the roles of salinity and temperature on *Stuckenia* and *Egeria*. The first experiment tested a range of salinities (0, 5, 10, and 15 ppt) and an elevated temperature of 25 °C on *Egeria*. Treatments represent current and potential future regimes in the Estuary. The first experiment is one of four temperatures (20, 23, 25, and 28 °C) to be tested. After two weeks, all *Egeria* died in the 15 ppt tanks. *Egeria* in the 10 ppt treatments decayed over the course of one month with an 85% decrease in total shoot length. The 5 ppt treatment demonstrated growth, with a 2.5% increase in new shoots. Plants in the 0 ppt treatment performed best, developing a total of 28% new shoot growth. Our results differ from past research where *Egeria densa* biomass greatly declined in salinities as low as 5 ppt. We hypothesize that elevated temperature may increase salinity tolerance of *Egeria* but will further evaluate this possibility at the different temperatures. These experiments will be repeated with *Stuckenia filiformis*. In an era of changing climate, these data will help to predict how distributions of native and non-native SAV will shift, and help to inform conservation and restoration efforts in the Estuary.

**Keywords:** climate change, submerged aquatic vegetation, salinity, temperature, and invasive

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Nearshore Linkages: The Roles of Native Oysters and Eelgrass as Living Shorelines in the San Francisco Estuary**

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The San Francisco Bay Living Shorelines: Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. This project builds on previous work by members of our team that advanced restoration methodologies and understanding of constraints and opportunities for both eelgrass and native oysters. Such habitat features, if scaled up beyond previous projects, have the potential to positively influence physical processes (such as waves and sediment transport) that determine shoreline morphology. In this project, we are further testing restoration methods, restoring critical eelgrass and oyster habitat, testing the individual and interactive effects of restoration techniques on habitat values, and beginning to evaluate effects on shoreline processes. Plots (32 x 10 m) of oyster substrate alone, eelgrass alone, or the two together in an additive design, are being compared to un-manipulated control plots along the San Rafael shoreline in the first phase of the project. Preliminary data show that restored habitat structure promotes increased abundance of numerous organisms relative to bare substrate, and that oyster settlement substrate (Pacific oyster shell bag mounds) in combination with eelgrass plantings alters the invertebrate community composition relative to either habitat alone. Small plots (1-m<sup>2</sup>, n=5) at San Rafael and along the Hayward shoreline (near Eden Landing Ecological Reserve) testing various oyster restoration substrates (including SF Bay-derived “baycrete” reef balls and interlocking “castle” blocks) are resulting in differences in native oyster recruitment by substrate and by site. This project will advance our understanding of restoration methodologies with an eye towards both habitat creation and shoreline protection in an era of rising seas and increasing storm surges.

**Keywords:** eelgrass, oyster, Olympia, Zostera, wave, erosion, sediment, restoration, shoreline

**Poster Topic:** Sustainable Habitats and Ecosystems

## Carbon Sequestration and Sediment Accretion in San Francisco Bay Tidal Wetlands

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Because of their location at the land-water interface, tidal wetlands play a critical role in relation to climate change. Sea-level rise will affect the long-term stability of tidal wetlands, depending on the magnitude of future increases in sea level and the ability of individual wetlands to accumulate sediment and keep pace with these changes. In addition, tidal wetlands can influence climate change by accumulating soil carbon, and there is growing interest to incorporate restored tidal wetlands into the state's carbon trading program. We measured sediment accretion and carbon sequestration rates at six natural tidal wetlands representing the salinity and geographical range of the San Francisco Bay Estuary. These sites also serve as analogs for long-term carbon sequestration in restored wetlands. We collected six cores at each natural wetland (two transects with three stations each). This approach allowed us to identify spatial variation both within and among wetlands in the Estuary. Cores from natural wetlands were dated using  $^{137}\text{Cs}$  and  $^{210}\text{Pb}$  profiles. Although accretion rates could not be measured at restored wetlands, cores were also collected from two restored wetlands for comparison of soil organic matter and bulk density. Most sites accreted 0.3-0.5 cm/yr, with slightly higher rates of accretion at low marsh stations. Carbon sequestration rates averaged approximately 80 g/m<sup>2</sup>/yr over the 100-year time span of  $^{210}\text{Pb}$  and were slightly higher for  $^{137}\text{Cs}$ -based rates. Variation in long-term carbon sequestration rates across sites and stations was much smaller than the variation in mineral inputs, with few significant differences in carbon sequestration rates. Based on these data, tidal wetlands within the Estuary are keeping pace with current rates of sea-level rise, although long-term sustainability is less certain. In addition, rates of carbon sequestration from this study could be used as a baseline for carbon sequestration in restored tidal wetlands within the Estuary.

**Keywords:** carbon sequestration, restoration, tidal wetland, climate change

**Poster Topic:** Sustainable Habitats and Ecosystems

## Restoring Soil Ecology and Native Plant Communities in Former Salt Pond Ecotone

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Restoring unique or heavily disturbed ecosystems often requires novel approaches to break the cycle of invasion and establish self-sustaining native plant communities. This experiment measures the effects of “compost tea” inoculated with local soils and wood chip mulch on native plant performance and seed establishment in salt marsh transitional ecotone communities at Eden Landing Ecological Reserve, a part South San Francisco Bay Salt Pond Restoration Project. Soils collected from local reference and restoration sites were used to inoculate a liquid “compost tea” blend to encourage the development of bacterial and fungal communities in a recently excavated area dominated by invasive species. Study plots were planted with *Grindelia stricta*, *Bacharis douglassii*, *Leymus triticoides* and *Artemesia Californica*, native shrub and grass species common to transition zone restoration. All plots were seeded with 15 different native species in a hydro-seeding mix. For each species, plants were planted at a distinct elevation in a block design and treated with bare soil, mulch, compost tea, a combination of compost tea and mulch, and a control with no alteration.

Plots were subsequently monitored for plant height and crown volume, native seed sprout rate from the hydro-seeding mix, soil nitrogen and total fungal and bacterial activity. It is predicted that plants treated with mulch and compost tea will have superior plant crown volume, higher rates of native seed sprouting, higher fungal and bacterial activity and lower nitrogen due to immobilization, and that treatments containing compost tea alone will show better results than plants treated with mulch alone. By testing novel restoration techniques in the former salt pond transitional ecotone, this study aims to develop land management practices in the tidal marsh ecotone and inform restoration efforts in the South Bay Salt Pond Restoration Project.

**Keywords:** South Bay Salt Ponds, Ecotone, Native Plants, Restoration, Soil Ecology

**Poster Topic:** Sustainable Habitats and Ecosystems

## Current and Planned Restoration in the Delta and Suisun Marsh

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The Sacramento-San Joaquin Bay-Delta estuary has experienced a severe decline in the condition of its natural resources and species that depend on them; thus, the Delta and Suisun Marsh have been and continue to be high-priority areas for restoration. With numerous restoration efforts having been implemented or being planned in the Delta and Suisun Marsh, it is important to have a spatial overview of these efforts to facilitate coordination and develop ecosystem connectivity. A GIS database of current and planned restoration projects was developed and that spatial information is displayed in this poster. Where available, pertinent information such as habitat type restored and project status is shown. The hope is that this information will assist in the efficient use of resources to facilitate and optimize restoration of natural communities and ecological processes in the Delta.

**Keywords:** Restoration, Geographical Information Systems, database

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Avian and Benthic Invertebrate Responses to Eelgrass and Native Oyster Restoration: Pre-Monitoring for the Living Shorelines Near-Shore Linkages Project**

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The San Francisco Bay Living Shorelines Near-shore Linkages Project is a multi-objective habitat restoration pilot project with the overarching goal to create biologically rich and diverse subtidal and low intertidal habitats, including eelgrass and oyster reefs, as part of a self-sustaining estuary system that restores ecological function and is resilient to changing environmental conditions. Phase I includes using a pilot-scale, experimental approach to establish native oysters and eelgrass at sites in Hayward and San Rafael. The USGS WERC San Francisco Bay Estuary Field Station conducted avian and benthic invertebrate pre-monitoring at each site from Nov 2011-April 2012, and will continue monitoring after treatments are installed in summer 2012. Our primary objective is to determine species and guild specific responses to restored habitat relative to control areas and pre-treatment conditions using a Before-After Control-Impact (BACI) design. We conducted high and low tide avian surveys twice monthly to record avian densities, instantaneous behavioral scans, and focal behavioral observations. To relate waterbird densities and behaviors to prey availability, we sampled invertebrates by taking 3 replicate benthic cores every 150-m along transects running perpendicular to shore. During pre-monitoring we recorded 55 avian species from 8 foraging guilds. Avian densities were highest at Hayward treatment and control sites, where small shorebirds predominated and reached densities of 2316/ha during their peak in January. Altogether we found 17 unique taxa representing four phyla and six classes of invertebrates at treatment and control sites, with highest densities and biomass at Hayward sites. Bivalves predominated at Hayward and provided the largest source of energy available to birds, while the San Rafael site had much lower invertebrate densities dominated by amphipods. These comprehensive baseline datasets will be used to understand species responses to restoration methodologies designed to protect shorelines while increasing habitat values for biological communities in the Bay.

**Keywords:** habitat restoration, subtidal habitats, migratory birds, shoreline resiliency, monitoring, invertebrates

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## Rhodia's Success Comes From More Than Science

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North Bay wetlands have been diked and drained for centuries to make land for development, including industries that left remnant pollutants in soils and water. Drained, subsided marshland and contaminated soils were two of the restoration challenges in the Peyton Slough Remediation and Restoration Project on Carquinez Strait in Martinez, California. Remediation, restoration, and successful management of urban-wildland interfaces is constrained by infrastructure. In 2003 Rhodia Inc. launched a remediation project to restore tidal wetlands by rerouting Peyton Slough, removing legacy side-cast dredged materials, capping the slough at approximately MHW, and 3 years after construction completion muted, seasonal tidal action was restored to upstream diked historic tidelands.

Annual post construction monitoring demonstrates the project's success in the tidally influenced, remediated areas. Water quality and habitat objectives established for the project are being achieved, exhibiting how a cap-in-place design can successfully contain contaminated soils, facilitate the restoration of approximately 18 acres of wetland and creation of 6 acres. Revegetation has been particularly successful, with 10-year vegetation cover and composition goals being met after 5 years.

In remediated, diked historic tidelands, the reintroduction of tidal action has required constant vigilance and adaptation as Rhodia and other stakeholders have worked to restore wetland without compromising existing infrastructure. Pipelines, subsided roadways, and culvert constrictions adjacent to the restoration present challenges; the elevation difference between the marsh and the roadways is less than one foot. The objective is to obtain daily marsh plain inundation, without flooding roadways or other infrastructure. With daily and seasonal tidal variation greater than the 1-foot freeboard, water management is critical and labor intensive. Relevant lesson –positive stakeholder relationships are valuable: 2011-12 rain patterns coupled with renewed stakeholder cooperation and resolve resulted in successful winter water management for the first time.

**Keywords:** wetland remediation, restoration, Carquinez Strait, diked historic tidelands,

**Poster Topic:** Sustainable Habitats and Ecosystems

## McCormack-Williamson Tract

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The U.S. Army Corps of Engineers CALFED Levee Stability Program provides a short-term strategy to address flood management and ecosystem restoration projects within the Sacramento-San Joaquin Delta. McCormack-Williamson Tract was purchased by The Nature Conservancy (TNC) for ecosystem restoration and the protection of wildlife in the study area and a Final EIR was prepared by CA Department of Water Resources (in coordination with TNC) to specifically address flood risk and ecosystem restoration.

The McCormack-Williamson Tract levees are constrained in height by a legal agreement and as a result the tract floods during high water events. If sufficient water accumulates, a downstream flood surge occurs when other portions of the levees are overtopped or fail. This flood surge poses a risk to lives, property, and infrastructure in adjacent areas. With this project there is an opportunity to reduce the risk to life and property from flooding or catastrophic breaching of the McCormack-Williamson Tract levee and to provide ecosystem restoration.

One alternative for consideration is to lower the height of the eastern levees (which would induce controlled flooding of the tract), reduce the height of the southwestern levee (which would reduce the potential for a flood surge when those levees are overtopped), increase the height of levees on adjacent islands to reduce flood risk, and install a new levee to protect the transmission tower. This alternative would also create tidal, intertidal, and shaded riverine habitat, providing ecosystem restoration benefits.

The McCormack-Williamson Tract project provides a unique opportunity to explore alternative methods and approaches to flood management and ecosystem restoration in the Delta.

**Keywords:** Ecosystem Restoration, Flood Management, Tidal, Levees, The Nature Conservancy, USACE

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Managing for Resilience in the Face of Climate Change: A Scientific Approach to Targeted Oyster Restoration in San Francisco Bay and Elkhorn Slough, CA**

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Coastal managers and decision-makers are faced with the challenge of designing conservation and restoration strategies that enhance the resilience of valued coastal resources to climate change. To design effective strategies, they need restoration-planning tools based on robust science. Critical questions include: What is the impact of climate-related stressors on valued resources relative to other anthropogenic stressors? How will climate-related stressors interact with other anthropogenic stressors? How does population connectivity influence resilience to climate change?

We are addressing these three questions for native Olympia oysters (*Ostrea lurida*) in San Francisco Bay and Elkhorn Slough. Our ultimate goal is to increase the resilience of oyster populations by improving restoration planning in light of climate change. We are taking a collaborative, joint fact-finding approach to this work, involving restoration practitioners and resource managers in the development and implementation of the research and in the creation of data products and management recommendations. Initial measurements of both climate change-related stressors and other anthropogenic stressors at multiple sites in each estuary reveal significant geographic variation in the mean and range of most stressors. Field surveys of oyster recruitment, density, size distribution and fecundity also indicate existing differences among study sites. We will combine these data with information about oyster responses to multiple stressors in the laboratory and emerging assessments of population connectivity via trace element microchemistry to generate predictions about which sites and source populations are best suited for restoration efforts. We then will produce restoration planning tools to aid practitioners and policy-makers in the selection of sites where oyster restoration is most likely to be successful under projected future conditions.

**Keywords:** anthropogenic stressors, joint fact-finding, *Ostrea lurida*, population connectivity, restoration planning

**Poster Topic:** Sustainable Habitats and Ecosystems

## Ecosystem Restoration Program Overview

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The Department of Fish and Game, United States Fish and Wildlife Service, and National Oceanic and Atmospheric Administration Fisheries Service are the implementing agencies for the Ecosystem Restoration Program (ERP). The ERP vision is to improve and increase aquatic and terrestrial habitats and improve ecological functions in the Bay-Delta and its watersheds to support stable, self-sustaining populations of diverse species for all life stages.

ERP is at the forefront of restoration efforts in the Delta and its watersheds, awarding over \$700 million in restoration grants to more than 500 projects since its inception in 1995. ERP has acquired or restored over 82,000 acres of habitat Program-wide and is currently managing over 70 projects ranging from research to full-scale implementation. ERP has funded and will continue to fund projects that will have an important impact on restoration and management practices.

To compliment these restoration activities, ERP is actively engaged in the development of performance measures and an adaptive management framework. Performance measures assess how restoration projects and related resource management activities support and fulfill ERP Strategic Goals and Objectives. The process of developing and refining the measures includes use of DRERIP conceptual models and oversight and review through a peer review process.

Communication, coordination, and collaboration with other agencies and organizations involved in Delta issues are extremely important to keep the science current and relevant. These efforts have allowed ERP to integrate its vision and goals into plans, programs, and projects of other agencies and organizations. ERP has sought feedback from these stakeholders to facilitate the development of efforts that reflect the goals and objectives of other governing agencies. ERP eliminates the need to “reinvent the wheel” while integrating and synthesizing policies, plans and projects to ensure collaborative and effective working partnerships.

**Keywords:** Ecosystem Restoration Program, Grants, Performance Measures, Conceptual Models, Coordination

**Poster Topic:** Sustainable Habitats and Ecosystems,

## Developing Tools for Landscape-Scale Restoration in the Delta

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Current regional management and restoration efforts in the Delta emphasize a landscape-scale approach to restoration. However, few tools are available that illuminate what large, interconnected habitat restoration should look like for the region, or how to design projects that successfully provide desired ecological functions. An understanding of landscape-scale pattern, process, and ecological function in the Delta under more natural (early 1800s) conditions can help managers and scientists develop appropriate, practical, and effective landscape restoration strategies that support desired ecological functions in the future. We are applying findings from a recently completed study of the Delta's historical ecology to help establish a regional guiding vision of landscape-scale restoration. Paired with contemporary knowledge and in coordination with a selected group of expert scientists we are: (1) performing an analysis of historical and contemporary habitat mapping to identify metrics that define landscape components and are reflective of valued ecological functions; (2) using the analysis to describe historical ecological functions of the Delta and compare past to current functions; and (3) developing and communicating landscape-scale conceptual models, restoration principles, and assessment metrics that illustrate potential future landscapes and highlight possible restoration constraints and opportunities. This tools will help create larger functional landscapes that are more resilient to future change.

**Keywords:** landscape connectivity, restoration, resilience, ecological functions, historical ecology

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Towards a Better Understanding of the Carbon Balance of a Grazed Pasture in the Sacramento-San Joaquin Delta, California Using Continuous Measurements of Soil CO<sub>2</sub> Concentration and Soil Respiration**

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Soil respiration is an important component of the terrestrial carbon cycle, and is the primary process by which carbon is lost from drained soils in the Sacramento-San Joaquin Delta, California. Understanding the processes and factors controlling soil respiration, and reducing the uncertainties associated with its measurement is essential to improving estimates of carbon budgets of terrestrial ecosystems in the Delta. In this study, we measured CO<sub>2</sub> concentrations at various depths in the soil in a drained, grazed pasture on Sherman Island using solid-state CO<sub>2</sub> sensors, and assessed the ability of the soil CO<sub>2</sub> gradient method to estimate continuous soil respiration. Briefly, the soil CO<sub>2</sub> gradient method estimates soil respiration by using both measurements of vertical gradients of soil CO<sub>2</sub> concentration and modeled CO<sub>2</sub> diffusivity in soil. Rates of soil respiration from the grazed pasture ranged between 1 and 5 μmol m<sup>-2</sup>s<sup>-1</sup> throughout the study. In addition, soil respiration was found to increase exponentially with temperature, in agreement with other studies. Finally, results from this study highlight the importance of selecting and testing the appropriate model for estimating CO<sub>2</sub> diffusivity in soil as large differences (up to an order of magnitude) in soil respiration were observed depending on which CO<sub>2</sub> diffusivity model was used. Soil respiration is an important process to consider when determining the carbon balance of ecosystems. The results from this study contribute to a better understanding of the factors that control soil respiration in terrestrial ecosystems in the Delta. This study will also be used to improve the partitioning of net carbon fluxes that we measure using the eddy covariance technique into carbon gains and losses from the ecosystem, which will result in better estimates of the carbon budget of conventional drained land-use types in the Delta.

**Keywords:** Soil respiration, Soil CO<sub>2</sub> concentration, carbon balance, Soil CO<sub>2</sub> diffusivity

**Poster Topic:** Sustainable Habitats and Ecosystems

## Ecosystem Restoration Program Signature Project Highlight

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ERP has funded a diverse set of projects that provide multiple benefits that address ERP Strategic Goals and Objectives. These projects have made significant progress toward understanding species requirements, habitat restoration strategies, ecological process rehabilitation, and stressor reduction in the Bay-Delta system. Examples of the types of ERP funded projects include habitat restoration, fish screens to reduce entrainment, removal of fish barriers to improve fish passage, projects to improve ecosystem water and sediment quality, at-risk species assessments, and hydrodynamic studies of sediment transport and flow regimes.

Scientific and management implications of ERP funded projects are numerous and range from providing technical assistance for development of the Delta Plan and the Bay-Delta Conservation Plan, to bridging data gaps, and prioritizing Bay-Delta system restoration needs. Reporting findings and achievements is an important step in moving towards a healthy Delta ecosystem. ERP is committed to knowledge transfer and communication of project success for future application.

**Keywords:** Ecosystem Restoration Program, Grants, Coordination

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Effects of Flooding and Anaerobic Conditions on Soil Greenhouse Gas Emissions in the Sacramento-San Joaquin Delta**

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Land subsidence following a 150-year history of reclamation and drainage in the Sacramento-San Joaquin Delta has resulted in significant emissions of carbon to the atmosphere in the form of the greenhouse gas carbon dioxide. Up to 50% of the carbon-rich peat soils have been lost. Such great losses jeopardize the sustainability of present drained land-use and undermine efforts to reduce California's carbon dioxide emissions. Controlled wetland restoration has therefore been proposed to address the dual concerns of land subsidence and carbon loss. Methane and nitrous oxide, two potent greenhouse gases, are however often emitted in greater quantities when soils are flooded and soil redox changes from oxic to anoxic. We therefore investigated how the total greenhouse gas emissions (carbon dioxide, methane, and nitrous oxide) may change as Delta soils change redox regime following flooding. We collected organic-rich soils from a pasture on Sherman Island and sampled trace gas emissions in a 3-week laboratory incubation using flooding and anaerobic headspace treatments. We found that anaerobic conditions and flooding suppressed carbon dioxide emissions by 50%. In contrast however we found that nitrous oxide emissions were stimulated temporarily in the anaerobic treatments. Interestingly we did not observe significant methane emissions even after a 3 week anaerobic incubation suggesting it may take a significant amount of time for methane production to become significant following wetland re-flooding. We conclude that flooding significantly suppresses carbon dioxide emission rates and that wetland restoration may be an effective measure in the Delta to reduce carbon losses. We also stress however that flooding can stimulate production of other greenhouse gases and the magnitude and temporal dynamics of these emissions warrant further investigation.

**Keywords:** carbon methane emissions wetland restoration land-use soil flooding

**Poster Topic:** Sustainable Habitats and Ecosystems

## Accelerating Sea Level Rise: Potential Responses of Tidal Wetlands

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**Problem statement:** Tidal wetlands are likely to face significant impacts in the coming century as sea level rises and salinity levels shift within the SF Bay Estuary. Maintaining pace with sea-level rise will require accumulation of both mineral and organic matter.

**Approach:** We have evaluated surface sedimentation rates at a range of wetlands across the salinity gradient within the Estuary. We have also measured above and belowground productivity and decomposition rates to evaluate the role of organic matter accumulation.

**Results:** Wetlands within the Estuary are accumulating enough sediment to keep pace with current rates of SLR (average accretion= 3-6 mm/yr) and are likely to maintain elevations with moderate increases in SLR. Aboveground and belowground biomass and productivity are inversely related to salinity. Rates of decomposition are rapid with up to 90% loss of organic matter after one year, but more organic matter remains in more saline sites. The salt marsh dominant *Salicornia pacifica*, however, decomposed at a faster rate than other species. While decomposition rates in saline sites are similar or higher than rates in freshwater sites, productivity is up to several times greater in freshwater sites leading to higher observed soil OM content. Interestingly, the peak in aboveground biomass occurs in the fresh wetland while the peak in belowground biomass occurs at the brackish wetland.

**Conclusions:** As long as suspended sediment concentrations remain constant, tidal wetlands will maintain themselves as SLR accelerates moderately. Projected increases in salinity, however, and the apparent overall trend of declining suspended sediment entering and leaving the Delta suggest that tidal wetlands may eventually lag behind SLR. Plant productivity and elevation distributions are being used to calibrate the Marsh Equilibrium Model (MEM) which can be used to predict marsh stability under a range of sea-level rise scenarios.

**Keywords:** climate change, tidal wetlands, sediment accretion rates, decomposition, productivity

**Poster Topic:** Sustainable Habitats and Ecosystems

## **Bird Response to Delta Restoration: Fine Scale and Landscape Variables that Determine Success**

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Studies of bird populations and their responses to habitat and landscape attributes at interior Sacramento-San Joaquin Delta restoration sites (Grizzly Slough, Decker, Sherman, and Twitchell Islands) are limited. In light of plans for large scale restoration of riparian and freshwater habitats in the Delta, an understanding of what constitutes successful restoration for Delta bird communities is extremely important. We conducted point count and vegetation surveys at 14 mitigation/restoration sites (n = 70) located within the north and west Delta during May and June, 2011 and 2012. Sites included various habitat types including shrub scrub, riparian, and freshwater marsh. We evaluated bird species composition and richness, and also tested regression models that related these variables to 1) fine-scale habitat attributes (tree and shrub species richness, tree and shrub percent cover, herb cover and non-native species richness), 2) landscape attributes (area, area to perimeter ratio, and age), and 3) adjacent land cover (grassland, crop, riparian, wetland and water). We found that mitigation/restoration sites attracted a wide array of native bird species including listed species, but species richness and diversity were low compared with larger and more contiguous riparian areas (i.e., Cosumnes River Preserve). Bird species abundance and richness were significantly lower at sites that were linear versus non-linear, smaller versus larger, younger versus older, and at sites with non-native versus native vegetation. Though both fine-scale habitat and landscape attributes were useful in predicting bird species abundance and richness, fine-scale vegetation attributes (e.g., tree richness, percent non-native (weedy) species) and habitat quality appeared more important than landscape context for predicting the abundance of certain bird species. These findings are used to provide guidance for restoration design and to suggest further research.

**Keywords:** Delta ecosystem restoration, freshwater, riparian, bird communities, songbirds. landscape, connectivity

**Poster Topic:** Sustainable Habitats and Ecosystems

## Lower Yolo Bypass Tidal Marsh Restoration Project

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The Lower Yolo Bypass Restoration Project involves restoring approximately 1,200 acres of tidal freshwater wetlands at the southern end of the Yolo Bypass in the northwestern Sacramento/San Joaquin River Delta. The Project area historically supported freshwater tidal marsh and lowland transitional habitats. This Project is being undertaken as partial fulfillment of the DWR 8,000-acre tidal restoration obligations contained within the 2008 USFWS Delta Smelt Biological Opinion and the 2009 NMFS Salmonid Biological Opinion for operations of the State Water Project and Central Valley Project delta facilities and under the 2009 DFG Incidental Take Permit for Longfin smelt. The Project could also serve as partial fulfillment of tidal restoration objectives under the Bay Delta Conservation Plan upon its approval. The primary goals of the Project are (1) to improve habitat conditions for delta smelt by enhancing regional food web productivity and (2) to improve habitat conditions for salmonids utilizing the Yolo Bypass by provide rearing habitats for out-migrating juveniles and migratory habitats for adults. The secondary goals are (3) to support a range of other aquatic and wetland-dependent species, including Sacramento splittail, and (4) to provide ecosystem functions of the Delta tidal marsh – floodplain – seasonal wetland – lowland grassland interfaces. The restoration design consists of constructing an extensive tidal slough network across the property to provide for high levels of marsh-aquatic connectivity and the lowering of lands just above high tide elevations to expand the footprint of restored tidal marsh. Construction is scheduled to begin in summer 2013.

**Keywords:** wetland, restoration, tidal, Delta, Yolo Bypass, delta smelt, salmon, splittail

**Poster Topic:** Sustainable Habitats and Ecosystems

## Restoring Prospect Island: Application of Adaptive Management

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The Department of Water Resources is planning the 1,600-acre Prospect Island restoration in the northwest Delta. Restoration to tidal marsh and tidal aquatic will partially fulfill DWR's obligations under the delta smelt and salmonid biological opinions on State Water Project and Central Valley Project operations for 8,000 acres of tidal restoration, by providing food web productivity and rearing habitats in a region established as important to these and many other species. Restoration will also fulfill larger restoration targets of the Bay Delta Conservation Plan. Restoration faces intriguing opportunities and challenges for how to provide fisheries benefits given (1) site topography – about one-third resides below emergent marsh vegetation heights, (2) site vegetation cover – it is mostly emergent wetland and riparian vegetation nearly 15 years after agricultural use discontinued, unlike nearby Liberty Island that was essentially a barren field when it breached, and (3) possible constraints on locating levee breaches along the Deep Water Ship Channel and/or Miner Slough. Restoration planning will apply the fruits of recent years' efforts advancing the science for Delta restoration, recovery of the many species and natural communities at great risk, and potentially interfering stressors, using that science in combination with site conditions to generate and evaluate a wide range of design options. The selected restoration alternative will in itself be an adaptive management study site. In addition to providing target ecological functions, the restoration needs to avoid or minimize problems with invasive species, adapt to climate change, and examine potential impacts to water quality, navigation, access to an adjacent property, flood conveyance, seepage onto Ryer Island, and levee erosion.

**Keywords:** restoration, wetlands, pelagic, delta smelt, salmonids, DWR, Cache

**Poster Topic:** Sustainable Habitats and Ecosystems

## Fire, Floodplains and Native Fish: Ethnoecology of the Cosumnes River

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Traditional Resource Management is an influential supplement to overall restoration policy and management practices. The Cosumnes River is located in the northeastern portion of the Sacramento-San Joaquin Delta of Central California. Prior to European settlement, this area was Plains Miwok territory, supporting an estimated population density of 57 individuals per square mile along riparian areas. Overall floodplain biodiversity and native fish productivity benefited from burning and other traditional management practices utilized by Native Californians. Ethnographic and archaeological data were used to reconstruct pre-European settlement traditional management practices. Ethnographic data was gathered from historical literature and local Miwok informants. Archaeological data from four Cosumnes River sites dating to the Late Period (1200 to 100 B.P.) were analyzed and compared to records of modern fish abundance and floodplain habitat modifications. This study synthesizes data from fish ecology, four archaeological ichthyofaunal site remains, ethnographic sources, and traditional knowledge to reconstruct the landscape of the lower Cosumnes River watershed prior to Euro-American settlement. Results indicate that traditional management practices, such as burning and harvesting plant materials in the floodplain, may have increased the productivity of floodplain rearing habitat, thereby increasing fish growth and reducing fish mortality. Loss of traditional tending practices compounded by widespread degradation of habitat, alteration of flows, and introduction of exotic species has resulted in the catastrophic decline of most California native fish species. Minnows and other native fishes that were originally abundant in lowland lakes, tule marshes, sloughs and slow moving sections of the river have diminished significantly or disappeared from pre-European settlement numbers. Based on this synthesis of multiple sources of information, it is likely traditional practices optimized habitat vitality for native fish species, attributing to higher fitness levels towards fluctuating environmental conditions.

**Keywords:** Ethnoecology, Eco-cultural Restoration, Traditional Resource Management, Cosumnes River, Native Fish

**Poster Topic:** Sustainable Habitats and Ecosystems

## **A Protocol for Monitoring the Vegetation of the Tidal Marsh Ecotone**

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The intertidal-upland ecotone is a zone of decreasing tidal influence, extending landward from tidal marshland or tidal flat up to or slightly beyond the maximum landward effect of tidal waters on plant community structure. The ecological functions of this ecotone have been gaining recognition within the regional community of natural resource scientists and managers. This protocol is designed for assessing the ambient condition of vegetation and the effectiveness of vegetation management in the ecotone. We collected data of multiple plant species at different positions in the ecotone, under various management regimes to identify plant species richness, which species dominate the ecotone, how richness and dominance vary across the ecotone, and how they vary with restoration design. We are assessing trajectory of plant species cover at each site over time. Analyses planned for summer 2012 will examine a three year dataset at five marsh restoration sites around San Francisco Bay. The goal of the analysis is to assess the effectiveness of restoration in achieving lasting increases in native plant cover.

**Keywords:** Tidal Marsh Ecotone Vegetation Protocol Wetland Upland Transitional

**Poster Topic:** Sustainable Habitats and Ecosystems

**Dream Blue: Bay Ocean Delta You - Unified Region Wide Pollution Prevention  
Public Outreach for the San Francisco Bay Delta**

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The poster will feature a new regionwide brand for stormwater and wastewater pollution prevention outreach to the general public in the San Francisco Bay-Delta-Ocean region. Since early 2011, stormwater and wastewater agencies in the nine-county Bay Area have been working together on a new, unified approach to pollution prevention outreach. The Bay Protection and Behavior Change Consortium collaborates on regional behavior change campaigns in order to achieve message effectiveness and cost efficiencies in reaching and influencing shared audiences. To embed a Bay protection message in the region's collective psyche and promote greater clarity between personal behavior and Bay water quality, a unifying brand was developed that will overarch permit specified topical campaigns that roll out over the next decade. The brand will be brand-new and launching in Fall of 2012.

**Keywords:** outreach pollution prevention brand wastewater stormwater regional communications Bay Delta

**Poster Topic:** Sustainable Habitats and Ecosystems