Effects of a Restored Freshwater Tidal Wetland Complex on Habitat for Imperiled Native Fish

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The recent collapse of pelagic fish populations in the Sacramento-San Joaquin delta has led to increased interest in habitat restoration. Successful tidal wetland restoration has occurred naturally in the northern delta at Liberty Island, where a levee breach inundated the island in 1998 and a highly productive tidal freshwater wetland has developed. Liberty Island and its surrounding sloughs, known as the Cache Slough Complex, are now considered key habitat for endangered native fish species. The Cache Slough Complex is a priority area for future habitat restoration efforts to protect and enhance native delta fishes. This study examines the hydrodynamic "footprint" of Liberty Island in the Cache Slough complex. Continuous monitoring of flow, temperature, tubidity, and salinity is coupled with quarterly sampling of biological resources over spring and neap tidal cycles. We report seasonal diel patterns in chlorophyll-a, zooplankton, and mysid abundance from Liberty Island and surrounding sloughs. Understanding the patterns of hydrodynamics and productivity is important to describe the habitat of pelagic fishes including delta smelt, and will help to identify and plan future restoration projects in the region.

Theme: Design & Monitoring Strategies for Habitat Restoration

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The influence of short-term flooding and draining on oxidation/reduction potential of San Francisco Bay tidal marsh sediment.

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The purpose of this study was to determine changes in oxidation/reduction potential (ORP) of San Francisco Bay tidal marsh sediment when subjected to a variety of short-term (minutes to days) flooding/draining regimes. Experiments were conducted using physical marsh samples placed within specially designed mesocosm chambers located at Don Edwards National Wildlife Refuge (NWR) in Fremont, California. A procedure was developed that enabled extraction and insertion into mesocosm chambers of the vegetated marsh samples that comprised almost completely intact sediment blocks and their associated biota from NWR marsh plain habitat. These sediment/biota samples were referred to as mesocosm experimental units or MEUs. Each mesocosm chamber was placed within an individual reservoir so that multiple tests could be performed simultaneously and independently. MEUs were instrumented with fixed (for the duration of each experiment) platinum probes that were densely spaced, replicated, and oriented to collect data at 5, 10, and 15 cm below the sediment block surface. Flooding involved the metered introduction into the mesocosm/reservoir of water (obtained from the same marsh system from which the MEUs were collected) so that the entire sediment surface was inundated. Draining involved controlled gravity outflow from the mesocosm/reservoir. MEUs were subjected to flood/drain test patterns that mimicked a wide variety of tidal conditions, including high marsh, middle marsh, and intertidal pond conditions as well as instantaneous flood/drain conditions. The results revealed relatively rapid and highly repeatable trends in changes of ORP both temporally and spatially (x, y and z axes). Relevant results from the mesocosm tests were comparable with in situ data from the collection site, indicating that the data from the experimental setup generally were representative of the natural environment. Implications of the results regarding tidal marsh processes that may be affected by sediment ORP variations will be discussed.

Key Words - *tidal marsh; ORP; mesocosms; sediment; flooding; draining*

Theme: Design & Monitoring Strategies for Habitat Restoration

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Hamilton Wetland Restoration Project

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The Hamilton Wetlands Restoration Project (HWRP) is one of the largest tidal wetland restoration projects in the U.S. involving the beneficial reuse of dredged sediment. The Project is a coordinated effort by stakeholders including and not limited to Federal/State/local agencies, environmental interest groups, commercial navigation groups, and local residents beginning in the 1980's.

The project design approach is to create a constructed template from which natural processes will complete restoration of natural wetland function. This project will restore tidal wetlands and other habitats on areas that were tidal wetlands until the early 1900's and were converted into non-tidal farm land and military uses by diking and draining. Lessons from monitoring of reference sites including Sonoma Baylands and Rush Creek are being been incorporated into the site design.

This poster will describe the construction approach to creating and restoring a mosaic of about 2,600 acres of tidal wetlands, seasonal wetlands, and associated upland buffer habitats at the HWRP with up to approximately 25 million cubic yards of dredged sediments from navigation projects within the San Francisco Bay Region. To date the project has placed more than 3 million cubic yards of sediment on the Hamilton Airfield and the State Lands Commission parcels. The Hamilton Airfield site is finished with most of the site preparation and is approximately mid way through sediment placement.

This presentation will review the lessons learned and challenges involved in constructing large wetlands areas by beneficial reuse of dredged sediments in an area adjacent to homes and businesses and in coordination with on-going military cleanup operations within the site. The presentation will also describe the next steps towards completing project design and construction including the potential involvement of community groups to assist with vegetation planting.

Theme: Design & Monitoring Strategies for Habitat Restoration

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Salt marsh vegetation pattern relationship to soil conditions and possible plant-soil feedback

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The successful restoration of some salt marsh sites may depend on the potential for multiple plant species to engineer the developing system via unique physio-chemical mechanisms. Salt marsh plant species exhibit diverse adaptations to the intertidal, particularly in their physiological regulation of water and salt uptake from the soil. A species' water and salt use may also affect surrounding soil conditions, potentially creating a positive ecosystem engineering feedback loop. Geophysical mapping of the soil electrical conductivity of a high-elevation, relatively pristine salt marsh permitted analysis of spatially-variable plant-soil relations in unprecedented detail (2-meter resolution). Geophysical surveys conducted during dry and wet soil conditions revealed similar soil conditions among marsh regions dominated by different plant species. Typical metrics of vegetation zonation such as elevation and distance-to-channel also failed to explain the plant distribution. We developed a new geophysical method to calculate soil saturation and salinity changes between dry and wet marsh conditions. Statistical analysis showed that the spatial pattern of changes in soil saturation and salinity between dry and wet tidal conditions was the most effective predictor of the vegetation pattern at the field site. We attribute this soil dynamics-related habitat differentiation to possible ecosystem engineering mechanisms that we hypothesize based on our data and the known salinity tolerances, competitive abilities, and physiological adaptations of each species. The geophysical methods employed in this study may provide an effective and inexpensive means to monitor the development of marsh-appropriate soil conditions and perhaps, with further study, to forecast corresponding marsh re-vegetation patterns.

Key Words - *salt marsh; vegetation zonation; soil conditions; geophysics; restoration*

Theme: Design & Monitoring Strategies for Habitat Restoration

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Coastal Habitat Restoration in San Francisco Bay

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Coastal wetlands support a unique community of marsh species and provide many important ecological services such as water filtration, flood control, and carbon sequestration. In San Francisco Bay, these wetlands support large numbers of wintering and migrating shorebirds, and have therefore been designated an Important Bird Area of global significance. Despite the huge loss of tidal wetlands in San Francisco Bay over the last century, the wetlands that remain account for 90% of California's remaining tidal wetlands, underscoring the importance of tidal wetland conservation and restoration. Audubon California is currently engaged in collaborative projects in San Pablo Bay and Richardson Bay with the goal of conserving, restoring, and enhancing coastal wetlands. In San Pablo Bay, a history of diking and ditching has led to depressions that hold water for long periods following spring tides and storms. This ponding leads to high mosquito production rates requiring pesticide treatment and to reduced vigor of marsh vegetation, both of which lead to degraded habitat for the federally endangered salt marsh harvest mouse and California Clapper Rail, the California threatened Black Rail, and other species. By improving drainage channels, this project will provide additional habitat for birds, enhance salt marsh vegetation for small mammals, and reduce the need for pesticide application. In Richardson Bay, we are working on a plan to rehabilitate an island that was created from dredge and upland fill soils in the 1960s that is now suffering from erosion and nonnative plant invasion. This project seeks to replace the retreating shoreline with gradually sloping sand and gravel beach that will provide roosting habitat for terns and shorebirds and potentially facilitate re-use of the island as harbor seal haulout. We also seek to rehabilitate existing tidal marsh and grassland habitats to improve wildlife habitat for shorebirds, waterfowl, and special-status native plants.

Key Words - *salt marsh restoration; shorebirds; coastal wetlands*

Theme: Design & Monitoring Strategies for Habitat Restoration

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Improving Water Quality Within Tomales Bay Through Large-Scale Restoration

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Wetlands are believed to play an important role in improving water quality, which is a crucial function for estuaries such as Tomales Bay. While Tomales Bay is viewed as pristine, its waters have been impacted by leaking septic tanks, agriculture, and mercury and are designated by the state as impaired under Section 303(d). These problems have galvanized efforts to improve water quality through both source reduction and restoration. The 550-acre Giacomini Wetland Restoration Project could have tremendous benefits for water quality by restoring a historic marsh diked for operation of a dairy ranch. Two-thirds of the Bay's freshwater input -- the principal contaminant source -- comes from tributaries upstream of the Giacomini Ranch. In 2007-2008, the National Park Service restored hydrologic connectivity to the Giacomini Ranch by removing levees, tidegates, and culverts; realigning leveed creeks; filling drainage ditches; and constructing new tidal channels. Unlike many diked areas in San Francisco Bay, the ranch had not subsided substantially since being diked (<1-3 feet), which not only speeds up the restoration timeline in terms of improving functionality, but provides some resiliency in the face of anticipated sea level rise. To determine success of restoration in improving water quality, the Park Service developed an innovative long-term monitoring program to assess water quality in the Project Area and reference wetlands before and after restoration. Computer modeling results had suggested that as much of 20 percent of the floodwaters from Lagunitas Creek could flow through the restored wetlands during 2-year storm events, leading to substantial reductions in pollutant inflow to Tomales Bay. Following restoration, pollutant concentrations have already decreased within the former dairy, which had the highest pre-restoration pollutant concentrations. However, the lack of large storm events during 2008-2009 may have reduced the newly restored marsh's effectiveness in reducing downstream pollutant loading.

Key Words - *restoration; water quality; habitat improvement; monitoring*

Theme: Design & Monitoring Strategies for Habitat Restoration

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Designing Seasonal Wetland Creation and Upland Habitat Enhancement on a Former Municipal Landfill, Berkeley Meadow, Berkeley, California

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LFR Inc. (LFR) designed three phases of the Berkeley Meadow 70-acre seasonal wetland creation and upland habitat enhancement program with the East Bay Regional Park District (EBRPD) at Eastshore State Park. Final design and construction for Phase I was completed in 2005, Phase II was completed in 2008 and Phase III is currently under construction. For Phases I and II agreements were facilitated between EBRPD and private interests under the EBRPD's Resource Enhancement Program allowing mitigation and endowments for long-term maintenance; Phase III was sponsored by the California Coastal Conservancy. The projects are supported by stakeholders including Sierra Club, Audubon Society, Citizens for Eastshore State Park, and Save the Bay. Existing condition characterization, hydrology studies, grading/planting plans were developed using updated topographic and vegetation survey data. Habitat mitigation plans, construction drawings/specifications and technical studies provided the foundation for final engineered wetland basins, soil cover criteria, native planting/seeding, and construction of 2,200+ linear feet of stabilized earthen trail, observation areas, fences, and gates. A wetland soil moisture balance was utilized to determine potential wetland creation area and avoid impacts to existing wetlands. Monthly water balance computations coupled with evaluation of direct surface runoff contributions supported development of the final design. Mass balance techniques and water levels were used to assess soil saturation, surface ponding potential and projected flows through interconnected wetland cells. Created wetland ponding and/or soil saturation was projected to extend from January through March for an average rainfall year (confirmed for Phase I). Lessons learned from previous phases helped refine Phase III plans/specifications allowing for seasonal/salt panne wetland creation while minimizing excavation and maximizing soil cover. Phase III also includes: habitat enhancement strategies for special-status bird species (white shouldered kite and northern harrier); updates to the plant/seed palette; control of invasive non-native vegetation; earthwork contingency planning; and pre-construction biological surveys.

Key Words - *seasonal wetland; water balance; soil criteria; mitigation; engineering*

Theme: Design & Monitoring Strategies for Habitat Restoration

Poster Board Number: 62. Submission Number: 121

Outer Bair Island Tidal Restoration

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The tides were recently restored to Outer Bair Island. This was the first completed component of a larger restoration project aimed at restoring 1,400 acres of the entire 2,600-acre Bair Island complex. Historically, the island complex (Inner, Middle, and Outer Bair Islands) was part of a large expanse of tidal wetlands that extended along the southeastern edge of San Francisco Bay. The island complex was diked for agriculture in the late 1800's. In 1946 the area was converted to salt production, which continued until 1965, though the legacy of wetland conversion remains. The goal of this 468-acre project was to restore a more natural tidal hydrologic regime and salt marsh habitat on Outer Bair Island. To complete the restoration, several specific construction activities were required. First, the perimeter levee was breached in two locations to restore tidal exchange between Steinberger Slough and remnant tidal sloughs within the island. Second, a pilot channel was excavated through the accreted perimeter marsh at the eastern breach. Third, the internal borrow ditch created when the perimeter levee was initially constructed was blocked with earthen ditch blocks on each side of the large breach in order to direct tidal flow into historic slough channels. Two additional ditch blocks were placed further south, adjacent to Corkscrew Slough to facilitate flow in the historic channels in anticipation of future breaches as part of the Middle Bair Restoration. Implementation of the Outer Bair Island project began the long process of restoring some of the historic wetland functions and values to this unique area. Our presentation will highlight design elements, construction completion, and subsequent monitoring data. This project will have myriad benefits for people and wildlife once sediments accrete and tidal marsh vegetation begins to colonize.

Key Words - *tidal restoration; salt marsh; salt pond*

Theme: Design & Monitoring Strategies for Habitat Restoration

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Beneficial Reuse of Dredged Sediment in Wetland Restoration

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Large scale restoration is taking place in San Francisco Bay and the Delta. The region's 13 largest permitted projects will result in nearly 40,000 acres of new wetlands. Among these major projects (all of which are diked former baylands) are the South Bay Salt Pond Restoration Project, the Montezuma Wetlands Project, the Hamilton/Bel Marin Keys Wetland Restoration Project, and several Napa-Sonoma and Delta projects. Increasing concerns about sea level highlight the vulnerability of levee-dependent habitats and the critical role of wetlands for flood control. Given the likelihood of accelerated sea level rise, the question arises as to whether or not the supply of sediment will be adequate to sustain the marshes after restoration. Strategic beneficial reuse of dredged sediment could be key to achieving the region's restoration goals. The CCMP, Ecosystem Habitat Goals report and the LTMS strategy planning documents all call for beneficial reuse of sediment. The most prominent examples of sediment reuse in construction are Montezuma Wetlands and Hamilton Wetlands whose designs incorporate large amounts of reused sediment. These will use 17 million cubic yards and 24.4 million cubic yards respectively. This poster discusses the role of sediment reuse in restoration around the Bay and Delta and will highlight unique habitats being created by the Montezuma Project. Montezuma is the only Bay/Delta project that accommodates beneficial reuse of non-cover sediment for wetlands restoration. It is also unique in that it is the largest single project in the Delta and has the potential to establish more brackish wetland habitat than any of the other large projects mentioned above, thus providing critical habitat for the endangered Delta smelt and threatened longfin smelt. Montezuma project designers are using adaptive management to plan for the inclusion of California least tern habitat at the site in response to observed nesting over three breeding seasons. Although not part of the original plan, managers have now included habitat for this species in the restoration plan. This paper will illustrate the importance of sediment supply from beneficial reuse to restoration activities in the estuary.

Key Words - *wetlands; restoration; sediment; beneficial reuse; tern*

Theme: Design & Monitoring Strategies for Habitat Restoration

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