Pickleweed Restoration in a Muted Tidal Marsh: Peyton Slough Remediation Project

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North Bay wetlands were diked and drained for a century 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 in Martinez, California. Eco Services Operations LLC., who currently owns the project site, launched a project in 2004 to remediate remnant contaminants and restore tidal wetlands. Construction was completed in 2006, and eight years of annual monitoring have been conducted. Monitoring has shown considerable use of the restored wetlands and slough across the food web including by benthic invertebrates, fish, river otter, waterfowl and shorebirds.

Dense, tall pickleweed (*Salicornia pacifica*) with adjacent refugia is potential habitat for the endangered salt marsh harvest mouse and California black rail. Establishing the target habitat, pickleweed, in the muted tidal marsh area has been particularly challenging due to 1) delays in initiating tide gate operations that resulted in the loss of initially sprouted pickleweed; 2) on-going tide gate operation constraints associated with adjacent infrastructure and construction projects causing marsh desiccation; 3) subsidence, which has narrowed the target tidal range and 4) historic slough traces and uneven settlement causing ponding and high spots that are unable to support hydrophytic vegetation.

Despite these challenges, native vegetative cover was nearly 70 percent by 2014, and largely dominated by pickleweed. This success is attributable to adaptive management activities such as soil redistribution, tide gate redesign, invasive plant control, and supplemental plantings providing restoration practitioners examples of issues and solutions that may be applicable to other muted tidal marsh restoration projects.

Keywords: pickleweed, muted tidal marsh, habitat restoration, adaptive management, contamination, remediation

Poster Topic: Habitat Restoration: Tidal Marsh

Experimental Propagation Methods for the Oro Loma Horizontal Levee Demonstration Project

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The Oro Loma Horizontal Levee Demonstration Project is constructing an ecotone slope at the Oro Loma Sanitary District facilities in San Lorenzo. The ecotone slope is designed to serve as a buffer to impending sea level rise, test nutrient removal from wastewater discharge, and restore upland habitat. The plant species assemblage for the project was chosen to mimic historic moist grassland/bayland ecotone habitat that has been largely eradicated from the bay.

The native plant propagation methods for the project are designed to reduce the cost of growing large numbers of plants in a nursery setting. Approximately 70,000 plants were grown to vegetate the ecotone slope utilizing various methods including bare root division propagation of rhizomatous species and annual seed increase, as well as container plants. Propagules were sourced locally from remnant plant communities, well-adapted to the climate and sea level fluctuations of the East Bay. The majority of plants were grown in a large scale and low-maintenance method at a division bed nursery constructed at the project site. This approach utilized these species ability to propagate rhizomatously, thereby reducing the labor and cost necessary for container plant maintenance in a nursery environment. The entirety of the propagation, including seed collection, was completed in a compressed timeline of roughly one year, reducing what is generally a two to three year process of planning and collection.

Expected outcomes for the plant propagation component of the demonstration project include healthy, rooted stock that is able to thrive and compete when outplanted into the newly constructed slope. Native annual seed mix will develop a cover crop, excluding annual invasive species as the rhizomatous species establish. The Oro Loma horizontal levee demonstration project demonstrates a low-cost and lower-intensive labor method for large-scale plant propagation and can inform propagation methods for future ecotone/transition zone restoration projects.

Keywords: Habitat Restoration, Native Plant Propagation, Horizontal Levee

Poster Topic: Habitat Restoration: Tidal Marsh

More than One Way to Catch a Bug – Macroinvertebrate Sampling Methods for Monitoring of Tidal Wetland Restoration Sites

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Problem Statement: Macroinvertebrates associated with vegetation and shallow water habitat, such as amphipods and insect larvae, have been historically under-studied in the Sacramento – San Joaquin Delta, though they provide an important component of threatened fish diets. Many methods that are used for epibenthic and epiphytic invertebrates in other areas prioritize diversity and presence of sensitive species (as index of biotic integrity) rather than biomass or productivity. The Fish Restoration Program (FRP) is tasked with monitoring the benefits of tidal restoration sites for Chinook Salmon, Delta Smelt, and Longfin Smelt. As such, FRP is primarily interested in differences in food production over time and between sites (biomass of invertebrates), rather than presence of sensitive species.

Approach: We compared several passive methods (scouring pads, Hester-Dendy disk sets, and leaf packs) to several active methods (sweep nets, oblique trawls, benthic trawls, neuston trawls, and scraping live plant material) to assess each method's ability to characterize invertebrate biomass and community composition. We hypothesized that some form of passive method would provide a standard method of invertebrate production that would be easier to compare between habitat types and between study sites.

Results: Certain methods had higher variability than others, and the effectiveness of artificial substrates in attracting colonists was biased toward certain invertebrate species.*

Conclusions: We used the results of this study to recommend subset of these methods that provide a standardizable, efficient, and representative sample of fish food production for inclusion in long-term monitoring plans.

*Results will be updated pending data to be collected July 2015

Keywords: monitoring, macroinvertebrates, wetlands, tidal restoration, Delta, sampling methods, fish

Poster Topic: Habitat Restoration: Tidal Marsh

Sonoma Baylands Wetlands Demonstration Project: Findings from 19 Years of Physical and Biological Monitoring

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Funded in partnership between the U.S. Army Corps of Engineers and the California State Coastal Conservancy, the 303-acre Sonoma Baylands restoration project was enacted in 1996 to test the application of dredged material to accelerate tidal wetlands restoration. Physical and biological success criteria, established by a review committee, formed the basis of monitoring that is now in its 19th year, representing one of the most comprehensive, long-term monitoring programs for a tidal wetlands project.

Summary of findings:

- Immediately after restoration, tidal exchange to the site was severely limited by the capacity of existing outboard channels. Tidal scour of these channels was initially gradual, then accelerated after 4-7 years.
- The site has converted from open water to intertidal flats and emergent marsh over time. With placement of dredged material and 1 - 2 feet of estuarine sedimentation, much of the site is at elevations suitable for colonization by emergent vegetation. Marsh vegetative cover is 58% and 83% in the Main Unit and Pilot Unit, respectively.
- Tidal channel erosion into the placed dredged material has been relatively rapid, resulting in an interior channel system similar in extent to natural reference marshes. Channel down-cutting into the former agricultural surface (beneath the dredged material) has been slower.
- Experimental peninsulas to reduce wave energy appear to enhance sedimentation (based on qualitative assessment), but predator usage of the peninsulas has not been assessed.
- 21 species of fish and 82 species of birds use the site; this number increased over time as tidal exchange improved. With open water converting to tidal flats over time, avian use has shifted away from waterfowl, towards shorebirds, which now comprise 94.2% of avian use of the site.

Keywords: Restoration, Sonoma, Wetlands, Baylands, Dredge Material, Channel Development, Wave Peninsulas

Poster Topic: Habitat Restoration: Tidal Marsh

Tidal Salt Marsh Vegetation Establishment at the Sonoma Baylands Wetland Demonstration Project: 18 Years of Post-Construction Monitoring

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Establishment of native vegetation is a primary indicator of restored ecosystem structure and function in tidal marsh restoration projects. When vegetation establishes more slowly than predicted, it is necessary to understand the site-specific drivers of vegetation colonization to determine whether corrective actions are needed. The Sonoma Baylands Wetland Demonstration Project is a 303-acre tidal marsh restoration project located in Sonoma County, California. The project site, formerly a diked salt marsh, was restored to tidal action by the U.S. Army Corps of Engineers in 1996. Before the levees were breached, dredged material was placed to raise site elevations and accelerate vegetation establishment. One of the project's restoration goals is to achieve 65% native salt marsh vegetation cover on the site within 20 years of restoration construction. Monitoring results for the first 15 years found that vegetation cover lagged behind design predictions, even after initially undersized tidal channels widened and normal tidal action was established in 2005. In 2012, we carried out a 15-year review of the site's progress and assessed why vegetation was establishing more slowly than anticipated. We determined that as of 2008, most of the site reached elevations within the range of mature Pacific cordgrass (*Spartina foliosa*). However, by 2012, tidal marsh vegetation cover was only 32%. Three hypotheses were put forward to explain the slow colonization: (1) physical conditions are suitable, but time is required for natural vegetation recruitment; (2) inundation stress from muted tides limits seedling establishment; and (3) wind waves restrict seedling establishment. Following the 15-year review, vegetation cover rapidly expanded from 32% cover (in 2012) to 61% cover (in 2013) to 72% cover (in 2014). The rapid expansion of vegetation supported hypothesis (1), and demonstrates that initial slow vegetation establishment can be followed by a period of exponential growth when physical conditions are suitable.

Keywords: Sonoma Baylands, tidal salt marsh, restoration, elevation, cordgrass establishment, abiotic

Poster Topic: Habitat Restoration: Tidal Marsh