The Baylands and Climate Change: What We Can Do

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The Baylands Ecosystem Habitat Goals, produced in 1999 by a team of more than 100 scientists, managers, and regulators, was a science synthesis that created a vision of what would be needed to restore functioning estuarine ecosystems in San Francisco Bay. Guidance from the Goals report contributed to the restoration of 7,000 acres of tidal marsh by 2009, with 30,000 more acres acquired and permitted for restoration in the coming decades. An Update to the science and recommendations of the Baylands Goals is underway that addresses climate-change projections and other drivers of long-term change to the end of this century. Using future scenarios based on climate-change analyses and marsh-accretion models, the Update considers future trajectories of habitat evolution and shoreline migration, the transition zone between Baylands and terrestrial areas, the connection between the Bay and the Baylands, risk to wildlife populations, and carbon accounting over time. Landscape visions for how to conserve and restore Baylands habitats, the processes that maintain their resilience, and the ecological functions they provide are given for the Bay region and its subregions. Recommended actions to achieve these visions are detailed at the regional, subregional, and local scales.

Keywords: Baylands, landscape-scale planning, ecosystem restoration, climate change, applied science
Session Title: Design and Management of Resilient Landscapes: The Baylands Goals Update
Session Time: Wednesday 10:20AM – 12:00PM Room 311-313

Baylands Habitat Evolution: How Sea Level Rise and Other Drivers of Change May Change the Bay

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Our understanding of tidal marsh processes in the Bay continues to advance as does our awareness of the interconnectedness of habitats. Over the next century climate change and other drivers, such as sediment and salinity, will create a more dynamic landscape with shifts in location and nature of these habitats. This raises two questions: how are Baylands habitats likely to evolve and what management actions can we take to guide their evolution in the near- and long-term. This paper summarizes how, through a collaborative process involving many Bay scientists, the 2014 Baylands Goals Update (BEHGU) starts to address these two key questions.

Presently, tidal Baylands habitats appear to be accumulating enough sediment to keep pace with near-term projections of sea-level rise. The future of these habitats depends significantly on the actual rate of sea level rise and the availability of suspended sediments in the Bay. However, greater uncertainty on their fate occurs towards the end of the next century. Similarly, the functioning of diked Baylands will be most impacted as sea level rise accelerates later in the century. Continued monitoring remains key to understanding the Baylands response to climate change, evaluating ongoing changes, and determining the accuracy of marsh modeling efforts

We find despite the numerous challenges, there are still options available for planners and land managers to adapt to these changes. Specifically we recommend a strong sense of the management action timeline, linking planning and implementation to physical thresholds; multi-objective and multi-habitat projects that can maximize cumulative benefits; immediate implementation of pilot studies to explore and validate recommendations; and flexibility from the regulatory community to allow for new and creative solutions which increase the resilience of Baylands habitat and function while protecting the ecological values of the Bay.

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Managing for Uncertainty--Maximizing Resilience of Plant and Animal Populations in the Face of Climate Change and Other Stressors

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Bayland plants and animals have evolved in California's variable climate, in a landscape marked by dramatic changes of salinity and sea level. Human activities have severely reduced natural habitats and remnant habitat is fragmented and degraded. Simultaneously, wildlife populations have been subject to multiple stressors such as contaminants, invasive species, and human-associated predators. Thus, the capacity of wildlife to adaptively respond to stressors is already limited, and will be reduced more in the future because: (i) climate change, and human response to climate change will alter habitat at an accelerated pace, and (ii) extreme events that affect wildlife, such as droughts, flooding, and storms, are expected to become more frequent and severe. We summarize insights gained and recommendations compiled from the efforts of the Wildlife Workgroup of the Bayland Ecosystem Goals Habitat Update Project, which address two principal questions, (1) How will populations of plants and animals in bayland habitats be affected by climate change? And (2) Which management actions will be most effective in restoring or protecting population health given multiple impacts?

The foundation of this synthesis is 32 case studies written by bayland scientists and that span a wide variety of taxa, including plants, invertebrates, and vertebrates, found in aquatic, wetland, and terrestrial habitats of the San Francisco Estuary baylands. To effectively address the challenges posed by new sediment, inundation, storm, and salinity regimes, we suggest how to promote robust, interconnected, and resilient populations. Maximizing resilience entails long-term planning of habitat protection and short-term responses to catastrophic events. Connecting habitats and reducing barriers for mobile species and facilitating recolonization by translocating less mobile populations are examples of such responses. Active and anticipatory management actions are needed to allow wildlife to weather the landscape-level changes and intensified stresses that climate change will bring to the estuary.

Keywords: Climate change, population resilience, wildlife, management recommendations, extreme events
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The Role of Carbon in the Development and Management of the Baylands

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Carbon accumulation from local plant production is an important process contributing to the maintenance of elevation and sustainability of tidal wetlands. In addition, carbon accumulation and greenhouse gas (GHG) emissions (carbon dioxide, methane, and nitrous oxide) affect overall climate regulation. However, little consideration has been given to these processes, and much remains to be learned concerning the past, present and historic role of carbon dynamics and GHG emissions for tidal wetland development and management. We reviewed available data to address these issues as part of the 2014 Baylands Goals Update (BEHGU). Based on our analysis of the area and elevation of diked and drained wetlands, approximately 1.2 million metric tons of carbon has been lost from former Bayland wetlands since diking and drainage occurred. Currently tidal wetlands sequester greater carbon per unit area than most ecosystems, with 14,560 metric tons of carbon sequestered annually across all tidal wetlands in the Estuary. Organic-rich soils in diked brackish marshes are likely to continue releasing carbon dioxide, while more mineral-rich soils in diked salt marshes are probably depleted of oxidizable carbon. Data are lacking to estimate emissions of carbon dioxide and other GHGs from diked areas or current tidal wetlands; however, sulfate likely limits methane emissions in high salinity wetlands. No data are available to evaluate nitrous emissions across the Baylands. Potentially, GHG reductions could be attained by reducing the extent of impounded freshwater behind barriers in Baylands, as well as recognizing the benefits of reducing nitrogen loading to coastal waters. The restoration of tidal wetlands within the region will result in increased soil carbon sequestration, and considering the salinity gradient across the estuary will likely result in the net removal of greenhouse gases. Improved quantification of on-going GHG fluxes across the landscape would be helpful to inform management decisions.

Keywords: BEHGU, Baylands Goals Update, climate change, wetlands, carbon sequestration
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Connection and Transgression: Designing a Dynamic Upland-Estuarine Transition Zone at Rush Ranch

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Accelerating rates of sea level rise in the San Francisco Estuary are challenging wetland restoration scientists and engineers to anticipate and plan for the gradual transgression of tidal habitats over adjacent upland areas. Without transgression, tidal wetlands in many locations throughout the San Francisco Estuary are anticipated to drown over the next 100 years, severely impacting ecological function and further restricting the distribution of habitats for special-status plants, fish, and wildlife. In many locations, the potential for estuarine transgression is constrained by incompatible land use practices, transportation and utility infrastructure, the predominance of non-native upland plant communities, and disconnection between fluvial and tidal processes. We developed and applied innovative science-based approaches to these constraints in order to design three wetland restoration projects at Rush Ranch in Suisun Marsh, which contains the largest remaining extents of tidal brackish marsh within the Estuary. These restoration approaches focus on the physical and ecological mechanics of habitat transgression, with a particular emphasis on fostering (1) native transitional plant communities that often include regionally rare and special-status species, and (2) sediment transport within and between fluvial and tidal environments. The implementation of these designs will serve as an emerging pilot test of the anticipated recommendations of the Baylands Ecosystem Habitat Goals Update (BEHGU) Project, and are expected to further inform wetland restoration efforts upstream in the Sacramento-San Joaquin Delta. These and related strategies are necessary to encourage the long-term sustainability of tidal habitats throughout the entire Estuary, especially in the face of climate change and reduced Estuary-wide sediment supply.

Keywords: BEHGU, transition zone, tidal wetlands, uplands, habitats, restoration, transgression, estuarine
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Experimental Adaptation Pilot Projects: Results to Date from Living Shoreline Reefs, Active Tidal Marsh Revegetation, and High Tide Refuge Island Construction

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The Coastal Conservancy and our partners are implementing several experimental pilot climate change adaptation projects to test specific approaches and methods in San Francisco Bay. There is a critical need to get started early on pilot projects which test new integrative design concepts and adaptive approaches, in order to gain knowledge and scale efforts into larger projects to achieve habitat results that may better facilitate resilience to future climate changes. These pilot projects have been thoughtfully designed in a collaborative approach within a strong scientific framework, and include frequent monitoring to assess outcomes and to compare replicated designs across a variety of sites and conditions. In 2011, the Conservancy and USFWS established a five-year program to rapidly improve habitat for California clapper rail (*Rallus longirostris obsoletus*) in tidal marshes of the San Francisco Estuary. Program components include constructing high tide refuge islands and rapid intensive revegetation with the goal of rapidly enhancing cover, nesting, and high tide refuge habitat for rails. In 2012, the Conservancy constructed the SF Bay Living Shorelines Project, 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, that is resilient to changing environmental conditions. Habitat features such as these all have the potential to achieve dual biological and physical goals: enhancing critical habitat features and function, while also positively influencing physical processes (such as waves and sediment transport) that determine shoreline morphology and baylands health. This presentation will focus on sharing key components of adaptation designs, preliminary results to date, permitting considerations, and lessons learned that can be applied to additional adaptation planning efforts.

Keywords: Coastal Conservancy, experimentation, adaptation, revegetation, high tide, refugia, living shorelines
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Addressing Climate Change in the South Bay Salt Pond Restoration Project

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The South Bay Salt Pond Restoration Project (www.southbayrestoration.org) is the largest tidal wetland restoration project on the West Coast. When complete, the project will restore 15,100 acres of former industrial salt ponds to a rich mosaic of tidal wetlands and other habitats. San Francisco Bay has lost an estimated 85 percent of its historic wetlands due to fill or other alterations. This dramatic decline in tidal marsh habitats has caused populations of marsh-dependent fish and wildlife to dwindle. It has also decreased water quality and increased local flood risks.

The highly urbanized setting of San Francisco Bay provides unique challenges for large-scale estuarine restoration, especially in the face of new threats such as accelerated sea level rise. Restoration of the South Bay salt ponds provides an opportunity to begin to reverse past trends of habitat degradation by improving the health of San Francisco Bay, as well as becoming part of a resilient shoreline protection portfolio for Bay-side communities. This presentation will examine the use of an adaptive management framework to achieve significant short-term success, while remaining viable in the long-term. This presentation will explore some of the innovative approaches to address climate change in tidal marsh restoration that are sometimes in conflict with current regulatory policies.

Keywords: salt pond restoration, BEHGU, Baylands Goals Update, wetlands
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San Francisco Bayshores: Patterns of Transformation, Migration, and Resilience

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The Baylands Habitat Goals Project provided a science-based vision for the distribution and abundance of baylands needed to achieve critically important ecosystem services for San Francisco Bay. Achieving this vision will require revising conservation strategies based on new understanding of the likely responses of the baylands to climate change, especially sea level rise. While there has been substantial research focused on the natural processes that create and maintain the baylands themselves, there has been less research about the various bayland interfaces most sensitive to changing sea levels, namely the foremarsh (Bay-marsh transition zone), the upland transition along the backmarsh (estuarine-terrestrial transition zone or "T-zone"), and the head of tide in creeks and rivers that flow through baylands (estuary-riverine transition zone). The 2014 update of the Baylands Goals Project recommends strategies to restore and manage these interfaces in the context of sea level rise. Here, we present findings from regional studies and local pilot projects that inform and test some of these strategies.

We find that the form and function of these interfaces between baylands and adjacent areas are strongly controlled by local hydrogeomorphic setting. Local foremarsh evolution is strongly influenced by suspended sediment supply and the presence of sediment trapping features (e.g., jetties and headlands). The T-zone varies in width depending on the amounts of terrestrial runoff, the width of the adjoining marsh, and the steepness of adjacent uplands. The head of tide position around the Bay is driven by local channel gradient and engineered channel crossings (e.g., roadways, and sewerage) that constrain upstream tidal inundation extent. Early implementation projects show how this information about physical drivers should translate into restoration design. Taken together, these findings provide a foundation for developing restoration priorities and site-appropriate, resilient bayland conservation strategies.

Keywords: baylands, transition zones, resilience
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Delta Landscape Metrics: Creating a Spatial Framework to Inform Restoration Planning

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The Delta was a 365,000 acre freshwater inland delta located in the middle of the state until the early 1800s. Since then over 97% of that marsh has been converted to other land use, and the remaining marsh fragments are small and isolated. With the native biological communities of the Delta now in crisis, plans for extensive ecosystem restoration are underway. While policy-makers and managers recognize the need to accomplish ecosystem restoration at a landscape scale in the Delta, we have relatively little information about how “the pieces should fit together” to create a resilient future landscape. Understanding the inherent physical and biological processes that maintain the landforms and their habitats and enable resilience will be critical to success.

We will present mid-project findings from the first detailed landscape analysis of Delta habitat change. We have synthesized historical and contemporary data sets to quantify and understand the Delta’s transformation from the perspective of life-history support for native wildlife and other key ecological functions. These landscape metrics provide a new level of understanding for quantification of change, spatial and temporal variation in processes and functions, and regional vision for future restoration opportunities.

Keywords: Landscape Ecology, Restoration Planning, Resilience, Spatial Metrics, Ecosystem Management
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Framework to Integrate Compliance and Effectiveness Monitoring for Water Quality and Habitat Conservation Plans

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Plans for water quality protection and habitat conservation need to be coordinated for their consistency and to share costs for monitoring and reporting. The CA Water Quality Monitoring Council has endorsed the Wetland and Riparian Area Monitoring Plan (WRAMP) as a framework to define data needed for regulatory and management decisions affecting water quality. WRAMP guides development of tools to meet these needs:

- “CARI” (CA Aquatic Resource Inventory) for comprehensive mapping of surface waters;
- "S&T" (Status and Trends) program plan for assessing net change in wetland acres;
- “Project Tracker” for mapping and sharing information about restoration and mitigation projects;
- “Online 401” for web-based application and tracking of CWA Section 401 certifications;
- “RipZET” for estimating the extent of riparian areas based on their needed functions;
- “CRAM” (CA Rapid Assessment Method for wetlands and streams),
- “Landscape Profile Tool” to summarize environmental information for user-defined landscapes;
- “EcoAtlas” for visualizing and sharing environmental data.

The WRAMP toolset can inform project proponents and regulators alike about avoiding, minimizing, and mitigating impacts to aquatic resources as directed by the US Clean Water Act and the CA Water Quality Control Act. The tools have been piloted in multiple eco-regions and reviewed by technical staff of targeted agencies, notably the State Water Resources Control Board, US Army Corps of Engineers, and US EPA. The tools meet the essential requirement to account for cumulative effects of implementation actions at the landscape scale.

The suitability of these tools for tracking and evaluating efforts to implement federal and state habitat conservation plans is being explored through the Placer County Conservation Plan. The expectation is that, with integration of wildlife habitat types and wildlife data into the toolset, WRAMP can help increase consistency in compliance and effectiveness monitoring and reporting across water quality and habitat conservation plans.

Keywords: monitoring, water quality, habitat conservation
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Aligning Policy, Regulation and Management with Habitat and Community Resilience Goals in the Bay and Delta (Moderator: Matt Gerhart)

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This facilitated panel session will explore the ideas from the earlier special oral sessions through the lens of policy, regulation and management, with an eye towards upcoming challenges and changes that will be needed to develop new solutions to climate change. The Bay Delta estuary will be dramatically affected by climates change as seas rise, sediment declines, runoff to the Delta from the Sierra changes, water temperatures rise, and water demands change. Strategies in the form of Recovery Plans, goals projects, laws and policies, or historical ecologies serve as entry points for initiating large scale conservation efforts. Identification of conservation objectives and what is possible to achieve in the context of past landscape alteration and future change are critical in developing effective resilience goals. The resolution of these issues at the landscape, community and project scales create the need for innovative robust planning, policy and implementation approaches.

Each panelist will begin with a ten minute statement providing their viewpoint on the challenges presented for long term management of the estuary in a climate change context. Panelists will then respond to "popcorn" style questioning via the moderator and audience regarding key issues. Topics and questions to be addressed will include the changes needed in adaptive management of resource projects; funding structures supporting future investments in restoration and infrastructure; integration of planning between and across the bay and delta; how to integrate habitat restoration with community protection or redevelopment in multi-benefit adaptation strategies; evolving water management and necessary infrastructure investments in a rapidly changing Delta; challenges facing us in watershed and sediment management, and strategies for allowing the transmigration of habitats and species. Panelists are experts on a range of planning, policy, funding and regulatory concerns across both the Bay and the Delta.

Keywords: Resilience, Climate Change, Sea Level Rise, Landscape Scale Policy
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