Regional Sediment Management: San Pablo Bay

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As sediment supply to San Francisco Bay continues to decrease and climate change leads to rising sea levels, sediment is becoming an increasingly important natural resource. Historically, sediment management in San Francisco Bay, and much of California, has focused on specific components of the sediment system in reaction to human needs (e.g. safe navigation channels, flood control). Conversely, Regional Sediment Management (RSM) is a more scientific and proactive approach to manage sediment within the context of the entire system. Through informed policy and decision-making, collaborative partnerships, and improved practices on a regional scale, RSM can reduce adverse impacts, leverage existing resources, enhance existing systems and habitats, and prepare the Bay Area for the future. In 2016, the San Francisco Bay Conservation and Development Commission (BCDC) began the second phase of its overall RSM plan development, this iteration focused on San Pablo Bay. Here we present a synthesis of this embayment's sediment dynamics, both historically and what we see today. Through stakeholder engagement and an investigation of the embayment's sources, sinks, and pathways, we can recognize where the surpluses and deficits are in the system and explore how we can restore this critical balance and become more resilient to future challenges. By identifying challenges and opportunities unique to San Pablo Bay, the concluding plan will be applicable to flood control managers, habitat restoration practitioners, and coastal managers in the region.

Keywords: Sediment, San Pablo Bay, Flood Control, Restoration, Dredging, Planning

Poster Topic Sediment

Seasonal Patterns in Sediment Deposition across Two San Francisco Bay Tidal Marshes

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Sediment deposition is an important component of accretion processes that allow tidal marshes to maintain their relative elevation as sea-levels rise. Suspended sediment concentration (SSC), elevation, tides, and distance to sediment source interact to determine deposition rates across the marsh. Seasonal variation in SSC, driven primarily by precipitation, has great influence on deposition rates. Drought and changes in precipitation may thus indirectly reduce tidal marsh sediment deposition, increasing their vulnerability to sea-level rise. We sought to estimate the influence of precipitation on sediment flux by measuring sediment deposition over the course of one year. We deployed sediment traps along transects perpendicular to large tidal channels and across a range of elevations at two tidal marshes in the San Francisco Bay estuary (salt marsh at Petaluma River and brackish marsh at Rush Ranch), replacing traps at 1-2 month intervals to capture seasonal variation. Similar to previous studies, we found sediment deposition was highest close to the channel and at lower elevations. We also found that deposition was greatest from January through June. Our results will inform modeling efforts to incorporate seasonality and climate into projections of marsh elevation under sea-level rise and potential future climate scenarios. In addition, our results can be used as a guide for future efforts to measure sediment flux by identifying the period most representative of annual deposition rates.

Keywords: sea-level rise, sediment deposition, climate change, tidal marsh

Poster Topic Sediment

Bathymetric Change within Alviso Slough as Salt Pond Restoration Progresses: 2010 – March 2017

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Two major concerns with wetland restoration projects in South San Francisco Bay are: (1) the potential for localized and regional erosion of intertidal mudflats and (2) increased channel scour remobilizing legacy mercury contaminants. This study uses high-resolution bathymetric surveys to address these concerns and quantify bathymetric change within Alviso Slough to date. Restoration of the Alviso salt ponds began in 2010 when tidal action was introduced to Pond A6 through levee breaches at four locations. As part of the adaptive management strategy a more cautious approach was taken with the larger, upstream A8 pond complex. Pond A8 has an adjustable flood control structure, allowing for the progressive introduction of muted-tidal action through a series of gates. Beginning in June 2011 one 5-foot wide gate was opened for a period of 6 months and the width and duration of the opening gradually increased until June of 2017 when all 8 gates were opened for the first time, creating a 40-foot-wide connection to Alviso Slough. We have collected bathymetric surveys of Alviso Slough on a semi-annual basis to document morphologic evolution resulting from the increase in tidal prism as well as natural seasonal variability. As of March 2017 we observed a net volume loss of nearly 60,000 m^3 of sediment from Alviso Slough, yet the nearby mudflats have either accreted or maintained their elevation. Patterns of sediment deposition and erosion vary both spatially and temporally. The dominant pattern has been of slough erosion in the winter when river discharge is greatest, followed by either no change or slight deposition with only localized areas of erosion during spring and summer months. This study provides critical insight into the processes governing morphological evolution of slough/intertidal mudflat/bay systems as levees are breached and the tidal prism increased, while informing future wetland management and restoration practices.

Keywords: Alviso, bathymetry, salt ponds, restoration, morphology

Poster Topic Sediment

140 Years of Morphologic Change in the San Francisco Estuary: The 1850s to the 1980s

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The discovery of gold in the Sierra Nevada foothills in 1848 forever altered the San Francisco Bay Area as population exploded and land use changed. Understanding and quantifying the bathymetric changes that have occurred in the San Francisco Estuary from the time of the Gold Rush to the 1980s is possible through the analysis of historic hydrographic surveys. Extensive hydrographic surveys of the estuary began in 1855 and were repeated every 20-40 years by U.S. Coast and Geodetic Survey, now NOS. This resulted in 5 survey periods: 1850s, 1890s, 1920s, 1950s, and the 1980s, which allow us to track complex patterns and changes in sedimentation. The estuary system had a net gain of approximately 250 million cubic meters of sediment between the 1850s and 1980s, with San Pablo Bay and Central Bay both gaining sediment, while Suisun Bay and South Bay lost sediment. Understanding sediment loss is complicated by human activities such as borrow pits, sand mining, and dredging. From the 1950s to the 1980s human activities caused more that 60% of the sediment lost in Central Bay. Because of changes to the estuary from natural and artificial causes, tidal flat extent declined more than 50% in all regions except South Bay. This historic look at the San Francisco Estuary is an important piece in understanding the sediment budget of the system as new restoration efforts continue to alter the geomorphic landscape and attempts are made to restore natural processes while combating the effects of sea level rise and climate change.

Keywords: bathymetric, sediment, historic

Poster Topic Sediment

A Comparison of Sediment Fall Velocity Estimates Using In-Situ Observations and Theoretical Methods

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One of the persistent challenges in studying cohesive and non-cohesive sediment dynamics is obtaining accurate sediment fall velocities using imperfect and proxy instruments. The precise determination of the sediment fall velocity (and hence sediment residence time and fate) is critical to both short-term sediment transport predictions and long-term shoreline restoration efforts. However, this parameter can be difficult to measure and it can be complicated by cohesive sediment flocculation. The problem is that changes in the particle size have been shown to bias the optical and acoustic backscatter instruments, which are inherently more sensitive to smaller particles. Therefore, the objective of this work is focused on characterizing sediment fall velocity and on analyzing the difference between traditional and novel techniques that account for flocculation. More specifically, we will present fall velocity results using the LISST instrument, fractal theory, and Rouse theory. Additionally, we will present a modified Rouse theory method for determining the sediment fall velocities separated on a class-by-class basis. We will show that by ignoring the difference between particle size classes, the traditional Rouse theory method will underestimate the sediment fall velocity. Overall, the sediment fall velocity observations and methods comparison will provide relevant insights and tools for more accurate predictions of sediment transport in the San Francisco Bay-Delta estuary.

Keywords: Cohesive sediment, flocculation, settling velocity, flow, turbulence

Poster Topic Sediment

Processes Governing Tidal Mudflat Width in South San Francisco Bay

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Estuarine intertidal flats are rich ecological habitats that evolve morphologically in response to changes in hydrodynamic forces, sediment supply, and sea level rise. To explore the processes governing tidal mudflat width, we use a combination of observations and 1D process-based modeling (Delft3D) of the mudflat-channel system at Dumbarton Bridge in South San Francisco Bay, CA. Bathymetric surveys collected approximately every 30 years from 1858 to 2005 document that mudflat width varied from 550 to 900 m. Mudflat width correlated with overall sediment gains and losses in the lower South Bay. Mudflats widened/narrowed when the lower South Bay was depositional/erosional. Simple 1-D modeling provides a possible explanation for the change in mudflat width at Dumbarton Bridge. Model runs with constant wave and tide forcing show bayward widening of mudflats when sediment supply, parameterized by suspended sediment concentration (SSC), is high. When SSC is low, mudflats narrow from wave erosion. An additional factor that controls mudflat width is the rate of sea level rise. Mudflats narrow when SSC is not high enough to provide the sediment required for the mudflat to vertically accrete at the same rate as the rising sea level. This study will improve our ability to assess the susceptibility of mudflats to human activities that may affect sediment availability, such as ongoing restoration projects and sea level rise.

Keywords: Mudflats, intertidal flats, modeling, sediment supply, suspended sediment, geomorphology

Poster Topic Sediment

Regional Sediment Management: Central San Francisco Bay

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As the sediment supply to San Francisco Bay from the Delta decreases and climate change leads to rising sea levels, sediment is becoming an increasingly important natural resource. Historically, sediment management in San Francisco Bay, and much of California, has focused on specific components of the sediment system in reaction to human needs (e.g. safe navigation channels, flood control, etc.). Conversely, Regional Sediment Management (RSM) is a more scientific and proactive approach to manage sediment within the context of the entire system. Through informed policy and decision-making, collaborative partnerships, and improved practices on a regional scale, RSM can reduce adverse impacts, leverage existing resources, enhance existing systems and habitats, and prepare the Bay Area for the future. In 2016, the San Francisco Bay Conservation and Development Commission (BCDC) completed its Central San Francisco Bay RSM Plan, the first phase of the overall RSM plan for the San Francisco Bay. The Central Bay contains many reaches that have very different land uses, population densities, shoreline types, and environmental conditions that make management at the embayment scale particularly difficult. The Central Bay RSM Plan synthesizes the embayment's sediment history and dynamics, current uses of sediment, the public outreach and planning process involved in the development of the plan, the challenges of managing sediment in Central San Francisco Bay, and provides recommendations for management actions, project activities, and studies that can be implemented along different reaches of Central San Francisco Bay.

Keywords: regional sediment management, sediment, Central Bay, planning, beneficial reuse

Poster Topic Sediment

Wetland and Open Space Restoration in an Underserved Community of San Francisco: Case Study of Yosemite Slough, San Francisco Bay

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The Yosemite Slough wetland restoration is the centerpiece of a plan to clean up contamination and create a 34-acre wetland and recreation park in the Candlestick Point State Recreation Area on the shoreline of San Francisco Bay in the Bayview-Hunters Point neighborhood of San Francisco. Restoration of the subtidal and emergent wetland and upland recreational park, funded and overseen by the California State Parks Foundation and Department of Parks and Recreation, provides enhanced wetlands and wildlife habitat, bird nesting islands, transitional and upland areas as buffers for sensitive habitats, public access to shoreline trails, and an environmental education center in a low-income, mixed use residential-commercial-industrial neighborhood. The original historical wetlands were lost due to development and fill with contaminated materials. The overall objective was to restore tidal action and mitigate potential risks to human health and the environment. Soil and sediment were analyzed for pesticides, polycyclic aromatic hydrocarbons, petroleum hydrocarbons, lead and other metals, and naturally occurring asbestos. Some metals were determined to be naturally occurring and asbestos is associated with local bedrock. Two hundred thousand cubic-yards of soil required excavation and relocation during restoration. Soil and sediment management for the wetland design included significant beneficial reuse as wetland cover materials and upland soil cover. Site-specific risk-based cleanup objectives were developed for future tidal wetland and upland recreation land uses. Our team collaborated with the larger restoration design team, contractors, and agencies attaining effective planning and management of the restoration. The project successfully supported a cost-effective strategy to restore tidal action and mitigate potential short- and long-term risks to human health and the environment through targeted excavation of highly contaminated soil and sediment, minimizing erosion, air quality impacts, and waste generation, as well as capping lower-level contamination using recycled on-site soil concentrations meeting regulatory-approved action goals with significant cost saving.

Keywords: beneficial use, sediment, habitat restoration, risk-based cleanup, sediment action goals

Poster Topic Sediment

Urban Wetland Restoration: Sediment Quality Action Goals for Success

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Restoring wetlands in historically impacted urban areas typically requires a process that includes applying sediment quality action goals to ensure an ecologically functioning and successful outcome, while satisfying applicable regulatory requirements. Action goals for a restoration project may be based on a combination of Federal, state and regional chemical screening levels, ambient levels, dredge reuse guidelines, and/or site-specific action goals. We review available sources of screening levels and sediment quality and beneficial reuse guidelines, including the National Oceanic and Atmospheric Administration, US Environmental Protection Agency, US Army Corps of Engineers, California State and regional agencies, New Jersey, Florida, and Port of Baltimore sediment criteria among others, as they apply to selected examples of restoration projects in San Francisco Bay. These cases are examples of challenges including beneficially reusing historic impacted fill material, lack of available "clean" sediments, vertical stratification of impacted sediments, limited availability of risk-based levels beyond local and site-specific studies, inconsistent methodologies associated with regulatory permitting and requirements, cost-benefit tradeoffs, and clear metrics for success. Use of regional ambient or lowest value screening levels for project-specific action goals may result in over-conservative sediment quality requirements that may be cost-prohibitive and abort or delay restoration projects, while action goals that are consistent with predictive ecological risk-based values may better optimize beneficial reuse of sediments. Recommendations for working with regulatory agencies and other stakeholders to develop and apply consistent sediment quality action goals that are protective of species composition and functional groups in a local ecosystem are presented in the context of restoration success stories and lessons learned.

Keywords: beneficial use, contamination, restoration, sediment action goals, sediment quality criteria

Poster Topic Sediment

Future Management of the Peyton Slough Remediation Project

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The Peyton Slough Remediation and Restoration Project in Martinez, California was designed to prevent contaminated soils from discharging into Carquinez Strait and improve subsided marshland within Peyton Slough. Eco Services Operations Corp., current owner of the site and a sulfuric acid regenerator, launched a project in 2004 to reduce mobility of legacy metal contaminants and restore tidal wetlands in the area. Construction was completed in 2006 and monitoring has documented use of the restored wetlands by benthic invertebrates, fish, river otter, waterfowl and shorebirds.

For ten years a collaborative stakeholder effort has worked to improve management and achieve multiple habitat objectives for Peyton Slough and its adjacent wetlands. We discuss elements of the remediation project, management objectives, and monitoring aimed at understanding fish community response to tide gate operations.

Keywords: Fisheries, remediation, restoration, UAV, drone, management, watershed, Slough, Carquinez, invertebrates

Poster Topic Sediment

Comparing Prospects for Recovery from PCB Contamination in SF Bay Margin Areas

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Prey fish collected in nearshore areas by the San Francisco Bay Regional Monitoring Program revealed extremely high concentrations of PCBs in several areas, highlighting a need to develop a more spatially discrete conceptual model than the one-box model used as a basis for the Bay PCB TMDL. A revised conceptual model was developed, and focus shifted to shallow intertidal and/or nearshore "margin" areas where impairment is greatest, where load reductions are being pursued, and where reductions in impairment in response to load reductions should be most apparent. The RMP has developed conceptual site models for a number of these areas, and used simple models to estimate PCB loads and mass budgets under different recovery scenarios. Flushing or burial of contaminated sediments are expected to be primary pathways reducing PCB concentrations in the future, but ongoing local watershed loads are also a major factor differentiating expected fate among margin areas. Although there is some evidence of recovery from past peak loads and concentrations of PCBs, recovery will likely stall without further reductions in ongoing loads. Large tidal prisms relative to volume in many margin areas suggest potential for rapid recovery, but slower than modeled recovery, and the spatial distribution of current concentrations suggest spatially and temporally finer-resolved monitoring data and modeling will be needed for more accurate forecasts.

Keywords: PCBs, sediment, margins, recovery

Poster Topic Sediment