South Bay Salt Pond Restoration Project

Restoring the Wild Heart of the South Bay

South Bay Science Symposium 2015:

Moving from Phase 1 to Phase 2
October 22, 2015
Abstracts of oral and poster presentations

Oral Presentation Abstracts (in order of appearance)

Sediment Dynamics Session

1. South Bay Suspended-Sediment Concentrations and Supply

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Continuous monitoring of suspended-sediment concentration (SSC) in lower South San Francisco Bay at the Dumbarton Bridge indicates that SSC doubled from water years 2000-2011 to 2013-2014. 2013-2014 SSC was at levels last seen in the 1990s. In 2000, SSC decreased in lower South Bay and throughout San Francisco Bay as a pulse of sediment from hydraulic mining in the later 1800s waned and the Bay crossed a threshold from transport to supply limitation of SSC. We hypothesize that the recent increase in SSC may be due to the ongoing drought in California. During a drought, net landward sediment transport in lower South Bay likely persists throughout the year and erodible sediment accumulates. Sediment is flushed out of lower South Bay by density-driven exchange with Central Bay when a large volume of freshwater from the Central Valley (greater than about 1.5 million acre feet in April, May, and June) enters Central Bay. Central Bay last received this quantity of freshwater in April 2011, and since then, sediment has likely accumulated in lower South Bay. Benthos monitoring samples collected at a station slightly north of the Dumbarton Bridge qualitatively indicate that the bottom material changed from shell hash to mud in mid-2012. This apparent accumulation of sediment may have caused lower South Bay to revert to transport limitation of SSC. Monthly transects and continuous data at more landward sites indicate that the increase is greatest in the vicinity of a natural constriction in the Bay where the Dumbarton Bridge was built. Continuous monitoring stations elsewhere in San Francisco Bay do not indicate that SSC has increased during the drought, so the increase is spatially limited to lower South Bay. Increased SSC may decrease light-limited phytoplankton production and may increase inorganic accretion on tidal marsh and in former commercial salt ponds that are being restored to tidal marsh.

2. Incorporating the Coastal Blue Band (CBB) aboard Satellites and Unmanned Aerial Surveillance (UAS): A Remote Sensing Toolkit for Mapping Intertidal Mudflats in South SF Bay

Brian Fulfrost, Brian Fulfrost and Associates (BFA); **Kristin Byrd**, Laura Valoppi, Amy Foxgrover, Bruce Jaffe, Susan De la Cruz, United States Geological Survey; YangQuan Chen, University California, Merced; David Thomson, San Francisco Bay Bird Observatory
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One key uncertainty identified within the South Bay Salt Pond Restoration Project (SBSPRP) Adaptive Management Plan is whether the use of mudflats as a sediment source for restoration will come at the expense of critical mudflat habitat. If so, erosion of existing mudflats may result in changes in foraging area and food resources, thus reducing the ecosystem benefits of this habitat to waterbirds and other species As a result, the SBSPRP requires methods for tracking changes to the distributions, extent and "quality" (as a food resource for foraging birds) of mudflats. One impediment to tracking mudflats using imagery is that they must be mapped while they are exposed at the lowest tides (mean lower low water, MLLW), due to restricted wavelength penetration in water for most sensors. An interdisciplinary team of scientists is developing a remote sensing toolkit for mapping mudflats that incorporates imagery from satellites and Unmanned Aerial Surveillance (UAS) that is both cost effective and modular. The first step involves the acquisition and mapping of mudflats from satellite imagery that includes the Coastal Blue Band (CBB), which has been shown to greatly aid the delineation of shallow water bathymetry. The USGS obtained two 1.3 meter resolution World View-3 (WV-3) satellite images of the entire SBSPRP study area close to the time of MLLW on April 24 and June 7 through the Commercial Remote Sensing Space Policy (CRSSP) Imagery Derived Requirements (CIDR) Tool. Ground truth data were acquired at the time of image acquisition to delineate the water line with a sub-meter accuracy GPS. The team is utilizing the CBB to map the extent and distribution of shallow water mudflats. Mudflats derived from the WV-3 imagery will be calibrated and compared to high resolution bathymetric data obtained in 2015 and compared to earlier high resolution bathymetry (2005-2012) to evaluate the efficacy of the method for tracking changes into the future. Our pilot study will also assess the efficacy of using the MLLW line, derived from high resolution Lidar, as a baseline for determining the lower "edge" of mudflat extent. Our second step, currently unfunded, will be to explore the use of integrating Unmanned Aerial Surveillance (UAS) with commercial cameras outfitted with CBB filters for tracking mudflat extent and quality. Mudflat "quality" here refers to the presence (and density) of biofilm along the mudflat. Third, we will compare and asses the ability of both the satellite and UAS based CBB imagery to delineate mudflat distribution, extent and quality.

3. Adaptive Management Response to Current Science on Sediment Dynamics

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Natural sediment accretion is vital to maintaining mudflat habitat and building tidal marshes that support a diversity of fish and migratory birds. Recent modeling studies in San Francisco Bay have indicated that rising sea levels coupled with declining rates of sediment supply by 2100 may result in the widespread inundation of the tidal marshes and mudflats surrounding the Bay. Therefore we are faced with the urgent challenge of accelerating marsh development to match the projected rates of future sea level rise by mid-century. There is general consensus among restoration managers and sediment scientists in support of undertaking tidal restoration sooner rather than later, in order to take advantage of the high suspended sediment currently in the South Bay system and give marshes a head start against sea level rise. In response to the current state of knowledge of sediment dynamics, we are now investigating and implementing various climate adaptation strategies to accelerate marsh development and prepare for rising sea levels. These strategies include an increased focus on building up marsh-upland transition zone habitat along levees and shorelines, adding marsh mounds inside restored ponds to dampen wave action and capture sediment, building in varied topographical features such as high-tide refugia islands, seeking cost-effective ways to raise subsided areas to marsh plain elevations by beneficially re-using upland dirt and dredged material, and augmenting natural sediment supply to the mudflats and breached ponds with open-water in-Bay placements of dredged material. We have also convened a Mudflat Working Group to

discuss cost effective methods for monitoring mudflat and sediment accumulation as our restoration efforts progress. Examples of these strategies will be highlighted.

Effects on Aquatic Species and Water Quality Session

1. Will Water Quality be Affected?

David Senn, Emily Novick, Philip Bresnahan, Rusty Holleman, San Francisco Estuary Institute; Maureen Downing-Kunz, United States Geological Survey.
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San Francisco Bay (SFB) has long been recognized as a nutrient-enriched estuary, but one that has exhibited resistance to some of the classic symptoms of eutrophication. However, recent observations suggest that SFB's resistance to high nutrient loads is weakening. The combination of high nutrient concentrations and changes in environmental factors that regulate SFB's response to nutrients has generated concern about whether SFB is trending toward, or may already be experiencing, adverse impacts due to elevated nutrient loads. In response to these concerns, regulators and stakeholders are working collaboratively to implement San Francisco Bay Nutrient Management Strategy (NMS) which lays out an overall approach for building the scientific understanding to support well-informed nutrient management decisions. This presentation will focus on observations from recent NMS-sponsored studies in Lower South Bay, investigating linkages between nutrient loads and ecosystem response, including interactions between the open Bay and former salt ponds undergoing restoration.

2. Effects on Aquatic Species and Water Quality: Will Other Species be Affected by the Restoration?

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Greater than 90% of tidal wetlands in the San Francisco Bay Estuary were reclaimed for urban and agricultural uses including industrial salt production ponds in the early 1900's. Currently the South Bay Salt Pond Restoration project (SBSPRP) is restoring up to 15,100 acres of former solar evaporation salt ponds in South San Francisco Bay to full-tidal, muted-tidal and managed wetlands to benefit the estuaries biota, and buffer coastal communities against sea level rise from climate change. However, concerns over adverse effects of restoration on the estuary have led the SBSPRP to adopt an adaptive management approach to restoration. In 2010, we began an effort to monitor and document the benefits of different salt pond restoration designs for fish and macro-invertebrates in an effort to facilitate adaptive management and guide future restoration designs. We conducted monthly surveys of restored salt ponds using a variety of sampling techniques in the Alviso Marsh, Eden Landing and Bair Island. We have documented over 90 species from 40 identifiable taxa of fish invertebrates using newly restored salt ponds. We discovered communities using full-tidal restoration pond were similar to adjacent sloughs and marsh habitat. Muted-tidal and managed salt ponds had similar species assemblages, supported fewer species than full-tidal ponds, and supported large populations of invasive species. It was clear that salt pond restoration provided benefits to fish and macro-invertebrates however; not all restorations were created equal. Muted-tidal and managed ponds also resulted in significant environmental regulation and costs to the restoration project. Our study results support full-tidal pond restorations as a preferred option for salt pond restoration in the San Francisco Estuary.

3. Adaptive Management Response to Current Science on Water Quality and Aquatic Species

John Bourgeois, California Coastal Conservancy
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From the very beginning of the project, during the Initial Stewardship Phase, managing the ponds to improve habitat for fish and wildlife while retaining water quality standards was a central focus. Through the years, many lessons have been learned in how to manage and design water management systems to keep water quality as high as possible. However, there are some inherent challenges in managing large shallow water ponds, especially during periods of drought and high temperatures. A better understanding of the regional water quality dynamics and how aquatic species are using these areas gives managers a more realistic framework from which to set our expectations. We have convened a Pond Management Working Group that not only discusses wildlife use of the various ponds, but attempts to link management actions to observed wildlife outcomes. In addition, design of new water control structures try to anticipate water quality and aquatic species movement to minimize any potential negative outcomes.

Mercury Session

1. Will restoration mobilize mercury in tidal sloughs?

Bruce E. Jaffe, Amy C. Foxgrover, Theresa A. Fregoso, Mark Marvin-DiPasquale, United States Geological Survey; Carlos Rey, Dano Roelvink, Mick van der Wegen, Fernanda Achete, United Nations Educational, Scientific, and Cultural Organization, Intergrated Healthcare Enterprises (UNESCO-IHE), The Netherlands; Greg Shellenbarger, and Dave Schoelhammer, United States Geological Survey
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Restoration can have unintended negative effects on the environment. A major concern for restoration of salt ponds in South San Francisco Bay, California, is the mobilization of mercury-contaminated sediment deposited in a 5-km stretch of Alviso Slough downstream from the New Almaden Quicksilver mining area, which was active from 1847 to 1976. The breaching of the Pond A6 levee that borders Alviso Slough in December 2010 and the opening and closing of the adjustable flood control structures at Pond A8 (which also borders Alviso Slough) since June 2011 have increased flow velocities in the slough and have resulted in bed-sediment scour. Nine high-resolution (1-m gridded cell size) interferometric sidescan swath bathymetry surveys collected from 2010 to 2015 reveal the patterns and timing of sediment scour and deposition. Scour is greatest in the vicinity of the Pond A6 breaches and during the winter when river flows are fastest. There is also a stronger relationship between spatially extensive scour and upstream river flow than with opening and closing of the flood control structure at Pond A8. The combination of bathymetric change analysis and Hg concentration data from nine 80 to 200 cm-long sediment cores collected in 2006 and 2012, has allowed us to estimate the volume of Hg mobilized since restoration began. We calculate that approximately 35 kg of Hg was mobilized during the 2010–2015 period, with the rate of mobilization increasing during winter months, as associated with fast river flows. About half of the Hg mobilization was associated with breaching of the Pond A6 levees, paralleling the trend in sediment mobilization. A numerical hydrodynamic/sediment transport/geomorphic change model confirmed the influence of river flow on Hg mobilization in Alviso Slough and indicated that the Pond A8 flood control structure, even if opened to full capacity, would not significantly impact overall Hg mobilization within Alviso Slough. The next phase of modeling will (1) explore the time frame required for the system to reach a new state of dynamic equilibrium that would slow sediment scour and Hg mobilization, (2) project the effects of sea level rise on morphodynamics, and (3) locate where Hg-contaminated sediment is deposited.

2. Will the South Bay Salt Pond Restoration Project increase mercury in fish and wildlife?

Josh Ackerman, Mark Herzog, Alex Hartman, Collin Eagles-Smith, Mark Marvin-DiPasquale, United States Geological Survey; Darell Slotton, University of California, Davis
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The South Bay Salt Pond Restoration Project plans to convert 50-90% of the former salt evaporation ponds into tidal marsh and managed wetland habitats. This large-scale restoration will remobilize sediments and alter food webs, and may result in changes to the distribution, availability, and bioaccumulation of methylmercury (the most toxic form of mercury) within the estuary. San Francisco Bay is known to have elevated methylmercury concentrations in biota that exceed several fish and wildlife toxicity benchmarks. We will summarize our long-term data on mercury contamination of birds and fish within the South Bay, including the distribution of mercury among species and habitats, long-term trends, and risk of mercury to bird health and reproduction. We will provide two examples of how wetland management actions have influenced mercury bioaccumulation, and discuss potential wetland management options to reduce mercury contamination of wildlife.

3. Adaptive Management Response to Current Science on Mercury

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Historic mercury mining in the Guadalupe River watershed has left a legacy of contamination for certain ponds in the Alviso Complex. Our collective efforts to restore these areas must be grounded in science that will ensure a safe path forward for the overall health of the bay. The construction and opening of a variable-width weir at Pond A8 has allowed the project to proceed cautiously toward full restoration for this set of ponds while studying the implications of allowing a direct connection to the bay. Results from the study of biota and physical processes inside the pond and the adjacent slough is informing the restoration trajectory of these sets of ponds. We have convened a Mercury Working Group to discuss on-going results from these studies in a timely fashion to assist with the more immediate decisions needed to manage this set of ponds. However, there are numerous other issues such as migrating steelhead and shoreline erosion that must also be considered in making management decisions.

Bird Use of Changing Habitats Session

1. The Effects of Salt Pond Restoration on Breeding Western Snowy Plovers

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The Pacific Coast population of the Western snowy plover is federally threatened as a result of poor reproductive success due to habitat loss, human disturbance, and increasing predation pressure. In the South San Francisco Bay, plovers nest almost exclusively in dry salt panne habitat provided by former salt evaporation ponds. Restoring these ponds back to tidal wetlands is beneficial for native wetland species, but also decreases the available habitat for breeding plovers. During phase one of the restoration project, three salt ponds that were used by breeding plovers were breached or converted to managed habitat. Pre-restoration, the average proportions of nests found in these three ponds in the South Bay were 18.5, 13.9, and 7.6 percent. Two additional ponds that are used by plovers are slated to be breached during the next phase of restoration. To support plover breeding success amid restoration, some remaining habitats have been enhanced with oyster shells. The 2015 breeding season was the first in which a large scale oyster shell enhancement was utilized, which provided cover and camouflage for adults, nests and broods. Preliminary results show that nests within large scale oyster shell plots had higher apparent hatch rates than depredation rates. Inevitably, breeding plover distributions will be affected within the restoration

footprint. The extent of their adaptability and the effects of restoration on overall breeding success will require further study.

2. Salt pond restoration and breeding birds: enhancing watebird nest habitat in managed ponds

Alex Hartman, Josh Ackerman, Mark Herzog, United States Geological Survey
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Former salt evaporation ponds provide critical breeding habitat for many waterbirds in South San Francisco Bay. Islands within these ponds are especially important, as they provide nesting habitat for large numbers of locally breeding waterbirds, especially Forster's Terns and American Avocets. Yet, the planned restoration of as much as 90% of these former salt ponds to tidal marsh habitat is likely to reduce waterbird populations that depend on ponds and islands for breeding habitat. In order to maintain current populations of pond-dependent breeding waterbirds, the South Bay Salt Pond Restoration Project aims to preserve and enhance several select ponds within the project area through island construction and water management. These efforts are to be evaluated in an adaptive management process by monitoring waterbird response over time. The USGS has been monitoring breeding waterbird use of former salt ponds in San Francisco Bay for 10 years, including evaluation of waterbird response to newly constructed islands in ponds SF2 and A16. Through these efforts, we have developed a comprehensive recipe for wetland and island design to maximize nest abundance and nest success of the most common island-nesting species (Forster's terns, American avocets, and black-necked stilts) within managed ponds in San Francisco Bay. In addition, we provide preliminary results of efforts to establish nesting colonies of Caspian terns in managed ponds SF2 and A16, through island construction and social attraction.

3. Evaluating Wintering Waterbird Response to the West Coast's Largest Tidal Marsh Restoration Project

Susan E.W. De La Cruz, Lacy M. Smith1, Stacy Moskal, United States Geological Survey; Cheryl Strong, United States Fish and Wildlife Service; John Krause, California Department of Fish and Wildlife; Natalie Washburn, San Francisco Bay Bird Observatory; and John Y. Takekawa, United States Geological Survey
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The urbanized San Francisco Bay (SFB) is a critical wintering and stop-over area for more than a million migratory waterbirds annually that rely on a mosaic of Bay habitats, including former salt ponds. The South Bay Salt Pond (SBSP) Restoration Project plans restore 50 to 90% of former salt production ponds to tidal marsh while maintaining the rest as foraging and roosting areas for migratory birds. Since 2002, the USGS Western Ecological Research Center has evaluated migratory waterbird use of pre- and post-restoration salt ponds in south SFB. Our approach has been to use monthly surveys, applied studies and modeling to evaluate avian response to this changing habitat. Long-term trend analyses of survey data indicates that overall waterbird numbers have nearly doubled across all pond complexes from 2003-2014. Dabbling ducks increased significantly during initial phases of the Restoration Project, while diving ducks, small and medium shorebird abundances showed declining trends initially but have strongly rebounded in recent years. We are currently evaluating habitat characteristics across and within ponds that are associated with high abundances of roosting and foraging waterbirds during winter. Preliminary results from this on-going modeling effort suggests that the importance of different habitat features varies among waterbird guilds. For example, foraging diving duck abundances were higher in deep, un-breached ponds, located close to the edge of the Bay, while foraging small shorebirds predominated in shallow, breached ponds containing islands. Our research highlights important habitat characteristics both within and across ponds, and provides a unique opportunity to guide future management and restoration decisions across a large landscape. With reduced pond area available in the future, the SBSP Restoration Project can use our findings to re-evaluate which ponds to restore to tidal marsh and how to modify remaining ponds to provide habitat for multiple guilds.

4. Adaptive Management Response to Bird use of Changing Habitats

John Krause, California Department of Fish and Wildlife
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We used info from Pond SF2 to redesign E12/E13 islands and enhance topography (roosting/foraging mounds/channels) as an example of Adaptive Management in Phase 1. Lessons from earlier restoration actions resulted in Pond E12-E13 design revisions including long comb style islands; to address cracking we built lower overall island elevations; we treated the islands with lime and enhanced the surface with low density gravel and oysters. By excavating flow channels and placing fill to create long shallow mounds with 25:1 slopes, which are mostly inundated at operational water levels, we provided more topographic diversity for foraging and roosting. This "Salinity Experiment" has been underway for two years and shows success in managing ponds with target cell depth and salinity. Intake and mixing basin discharge continues to operate with similar results of Initial Stewardship Plan implementation. Challenges remain with respect to Water Quality which were maintained, but not improved.

Preliminary interpretation on how ponds operated in the past few years shows inter-annual variation but overall similar in reaching target conditions. In the coming year we will incorporate USGS-DeLaCruz study analysis, interpretation and recommendations. Also will compare 10-year dataset synthesis when available later this year, and may refine operations. We may also use applied science from USGS and DU models to optimize future operations, including a model to evaluate habitat characteristics across and within ponds that are associated with high abundances of roosting and foraging waterbirds during winter. Preliminary results from this on-going modeling effort suggests that the importance of different habitat features varies among waterbird guilds. A spreadsheet box-model is being developed by DU to continue to refine operations and performance of reconfigured ponds.

Poster Abstracts (alphabetical by primary author's last name)

1. No Rain Much Pain: Challenges and Lessons Learned in Transition Zone Restoration During a Drought

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The transition zones between coastal marshes and upland areas of San Francisco Bay are critical habitat for hundreds of species, some threatened or endangered. Transition zones are integral habitat for wildlife as they move between marshes and uplands during high tides and storm surges. These areas provide cover from predators, especially during high tides, and provide a food source for insects, birds, reptiles, and small mammals. Save The Bay's Habitat Restoration Department has focused on enhancing transition zones around the Bay for the past 15 years. In 2013 Save The Bay began work at a 4.25-acre site at Eden Landing Ecological Reserve in Hayward, CA, where restoration efforts have been challenged by difficult conditions including drought, harsh soils, and a limited work window due to the site's proximity to habitat for a federally threatened species.

Unpredicted drought conditions lead to a failed hydroseed attempt, an increased need for supplemental watering for newly installed plants, and an increase in staff resources. The reduced rainfall also slowed the potential leaching of salt on the grated levee, leaving a harsher medium for plants to try and establish and a higher mortality of species with lower salt tolerances. Site visits by restoration staff were also limited by proximity to Snowy Plovers who use the adjacent former salt ponds as nesting grounds. The reduced access to seedlings between November and March limited the amount of watering and maintenance that could be done during spring and summer. These challenges provided insight into how to experiment and adjust our restoration strategies, such as adding soil amendments and modifying the plant palette, to increase plant survivorship. These lessons learned can be applied to existing and future transition zone restoration designs.

2. Management Approaches for Reducing Triclosan Releases: Status of Initiatives in the South San Francisco Bay Area

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Triclosan is a diphenyl ether derivative used in more than 140 consumer products since the 1960s. Recent trade names include Biofresh® and Microban®, which are slow release triclosan products embedded in many plastics, kitchen utensils and clothing. Triclosan has been a registered pesticide with the USEPA since 1969 functioning as a fungicide and bacteriostat and used in commercial, institutional and industrial premises and equipment, including conveyor belts, fire hoses, ice-making equipment, and as a material preservative in a wide variety of products, including paint, caulk, mulch, textiles and toothpaste.

Municipal wastewater treatment effluent and stormwater runoff are the primary migration pathways for triclosan to the environment. In a 1999-2000 U.S. Geological study, triclosan was detected in 57% of 139 U.S. waterways. It has been detected in 97% human breast milk samples, 47% plasma and 75% urine samples. Laboratory studies suggest that triclosan can act as an endocrine disrupter in fish and mammals. Triclosan is regulated by both the Food and Drug Administration and the USEPA. However, the FDA missed its 2011 deadline for reviewing triclosan, and has not set a date to complete it. The EPA approved the re-registration of triclosan in 2008, eliminating one use-- in paints-- and has scheduled an early re-registration review beginning in 2013. There are no federal drinking water standards for Triclosan. Minnesota is the only state with a drinking water guideline of 50 parts per billion that was developed in 2011.

Triclosan has been considered an emerging contaminant in the Bay Area since 2001. Has the "unified regional approach" recommended in the 2006 White Paper prepared by the Emerging Contaminants Workgroup of the Santa Clara Basin Watershed Management Initiative been implemented? How is California doing compared to other states and international activities? In 2013, the San Francisco Estuary Institute downgraded triclosan to Tier 2—Low Concern.

This poster describes the current status of South Bay management tactics and compares them to other initiatives to reducing triclosan discharges to surface water. 2010 data from sediment cores in four urbanized estuaries outside of California suggest that sediment concentrations were the highest in the 1960s and 1970s, but may be rising again. Management strategies include regulation, reformulation, legislative action, advocacy groups and public awareness. What needs to occur so that triclosan can be considered a long-term success story in the South Bay? What steps can you take to help this happen?

3. CHARG (Coastal Hazards Adaptation Resiliency Group) a collaborative to address San Francisco Bay regional sea level rise and extreme tide impacts – come learn how we are creating integrated resiliency solutions from a technical, policy and funding perspective to address this slow impending emergency

Ellen Cross, Alameda County Flood Control and Water Conservation District
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Planners, scientists, engineers, and policy makers from local, state, and federal agencies are sharing responsibility to protect people and property from sea level rise and extreme tide to enhance the Bay Area's shoreline ecosystems. Near-shore Bay Area properties and assets are valued in the trillions of dollars. Hundreds of thousands of people live and work in flood-prone areas around the Bay. Major critical infrastructure—airports, roads and rail, water and wastewater treatment facilities, and power and telecommunications utilities, for example—are located within flood-prone areas and will require billions of dollars of protection investment to ensure the safety and livelihood of our communities. The waters of the San Francisco Bay know no boundaries. Efforts to control coastal flooding in one area may cause the Bay waters to flow to adjacent areas. Controlling riverine flooding in the region's rivers and creeks is an ongoing challenge, but managing the impacts of rising waters of the San Francisco Bay will require unprecedented efforts. CHARG will provide a unified voice to advance necessary partnerships, resources, and collaboration to implement solutions. Dedicated CHARG working groups will integrate technical, policy and funding approaches to address the complexities of coastal hazards mitigation in support of our interdependent communities. By fostering partnerships that support collective solutions, CHARG organizations are united in our commitment to public safety, economic vitality, healthy ecosystems, prudent surface and groundwater management, and sustainability. Our collaborative plans and projects will provide Bay Area coastal communities with greater resiliency and improved quality of life. Learn more on how your agency and community can be part of the solution!

CHARG Steering Committee: Alameda County Flood Control and Water Conservation District; California State Coastal Conservancy; Bay Area Regional Collaborative; Santa Clara Valley Water District; United States Army Corps of Engineers; Contra Costa County Flood Control and Water Conservation District; San Francisco Bay Conservation and Development Commission; California Department of Water Resources; Marin County Flood Control and Water Conservation District; San Francisquito Creek Joint Powers Authority; Federal Emergency Management Agency; and City and County of San Francisco.

4. Estimating Mercury Mobilization from Scour using a Series of Bathymetric Surveys of Alviso Slough, South San Francisco Bay, California

Theresa A. Fregoso, Amy C. Foxgrover, Bruce E. Jaffe, United States Geological Survey-Pacific Coastal and Marine Science Center; and Mark Marvin-DiPasquale, United States Geological Survey, Branch of Regional Research, Western Region
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A major concern for restoration of salt ponds bordering Alviso Slough in South San Francisco Bay, California, is mercury (Hg) mobilization from the scouring of Hg-contaminated sediments, a legacy of the New Almaden Quicksilver mines that were active from 1847 to 1976. The breaching of Pond A6 levees during December 2010 and the opening and closing of the adjustable flood control structures at Pond A8 have increased flow velocities in Alviso Slough resulting in sediment scour. The combination of bathymetric change measurements calculated from nine high-resolution (1-m gridded cell size) interferometric-swath bathymetric grids of Alviso Slough (Foxgrover et al, 2011) from surveys collected between 2010 and April 2015, and Hg concentration data from nine 80 to 200 cm-long sediment cores collected in 2006 and 2012, has allowed us to estimate the volume of Hg remobilized since restoration began. The spatial distribution and volume of eroded sediment was calculated by differencing bathymetric surveys taken between 2011 to 2015 with one taken during 2010 (pre-breach). These data are coupled with total Hg concentrations measured from the sediment cores to track the progression of Hg remobilization since initiation of restoration. This study estimates the total Hg mobilized by sediment scour as the product of spatially interpolated Hg concentrations for each 20 cm depth interval and its corresponding observed volume of erosion. Hg mobilization has increased since the start of this project with the bulk of the mobilization occurring in the vicinity of the A6 breaches. The first change period from 2010 to October 2011 mobilized an estimated 7.8 kg of Hg. In the period between 2010 and the most recent survey (2015) an estimated 34.2 kg of total Hg had been mobilized. This information coupled with rates of erosion (see poster by Foxgrover et al. 2015) provides critical data for adaptive management strategies hoping to limit the dispersal of potentially harmful Hg into the South San Francisco Bay system.

Foxgrover, A.C., Finlayson, D.P., Jaffe, B.E., and Fregoso, T.A., 2011, Bathymetry and Digital Elevation Models of Coyote Creek and Alviso Slough, South San Francisco Bay, California (ver. 2, March, 2014): U.S. Geological Survey Open-File Report 2011-1315, 20 p., http://pubs.usgs.gov/of/2011/1315/.

Foxgrover, A.C., Jaffe, B.E., and Fregoso, T.A., 2015, Mapping bathymetric change in Alviso Slough as salt pond restoration projects progress, (abs.) 2015 South Bay Science Symposium, Mountain View, CA.

5. Mapping bathymetric change in Alviso Slough as salt pond restoration projects progress

Amy C. Foxgrover, Bruce E. Jaffe, and Theresa A. Fregoso, United States Geological Survey-Pacific Coastal and Marine Science Center
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The potential for localized and regional erosion of intertidal mudflats, sloughs, and channels is a major concern associated with salt pond restoration activities in South San Francisco Bay. In 2010 the USGS collected bathymetry of the far South Bay in the vicinity of the Alviso pond complex to establish baseline bathymetry prior to the breaching of Pond A6 levees and opening of gates at Pond A8 (Foxgrover et al., 2011). Interferometric sidescan swath mapping was used to generate high resolution (1 m cell size) bathymetric grids of the far South Bay extending east of Calaveras Point and into Alviso and Guadalupe Sloughs. Between October 2011 and April 2015 an additional eight surveys were conducted to monitor bathymetric change in this region as restoration progresses. Thus far, the greatest amount of erosion has occurred within Alviso and Guadalupe Sloughs in the vicinity of the A6 breaches. From 2010 to 2015 the nearby intertidal mudflats have either maintained their elevation or even been slightly depositional. Although patterns of deposition and erosion vary along the distance

of the slough and also thru time, there has been a dominant pattern of erosion in the winter and either no change or slight deposition with only localized areas of erosion during spring and summer months. Our measurements of scour within Alviso Slough, in combination with analyses of sediment cores by Marvin-DiPasquale and Cox (2007) enable a quantification of legacy mercury remobilized within the slough since 2010 (see poster by Fregoso et al., 2015), and provide critical insight into morphological evolution of slough/intertidal mudflat/bay systems as levees are breached and the tidal prism increased. These data are critical to the adaptive management of phased restoration plans and continue to play a key role in determining the configuration and seasonal operation of flood control gates at Pond A8.

Foxgrover, A.C., Finlayson, D.P., Jaffe, B.E., and Fregoso, T.A., 2011, Bathymetry and Digital Elevation Models of Coyote Creek and Alviso Slough, South San Francisco Bay, California (ver. 2, March, 2014): U.S. Geological Survey Open-File Report 2011-1315, 20 p., http://pubs.usgs.gov/of/2011/1315/.

Fregoso, T.A., Foxgrover, A.C., Jaffe, B.E., and Marvin-DiPasquale, M., 2015, Estimating Mercury Mobilization from Scour using a Series of Bathymetric Surveys of Alviso Slough, (abs.) 2015 South Bay Science Symposium, Mountain,. . The team now has funding from the California Coastal Conservancy to complete developing this Decision Support System by calibrating and validating our models to San Pablo Bay. This phase may also include expanding our geographic scope up river valleys since preliminary calculations of upland transitional abundances indicate they are inadequate given sea level rise projections.

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6. Prioritizing Land Management at the Bay's Margin

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Projected climate change impacts have highlighted the importance of Estuarine-terrestrial transitional habitats to conservation of the tidal marsh ecosystem. And projects such as the South Bay Salt Ponds Restoration have made them a greater part of their designs. But where do opportunities and constraints exist within the estuary with regards to upland transitional habitats? SFBBO with Brian Fulfrost & Associates piloted a study (funded by the USFWS Local Coastal Program) to map the distribution and abundance of upland transitional land surfaces, and then prioritize them on their utility to tidal marsh ecosystem management. That project included working with regional specialists to describe upland transitions in detail. The description guided the development of habitat metrics to work with available regional datasets such as land cover and use, as well as spatial metrics of habitat size, shape and proximity. The metrics were indexed during the pilot study, creating habitat and conservation scores to rank each area's value to the tidal marsh ecosystem relative to others

7. Active Revegetation to Benefit California Ridgway's Rail (Rallus o. obsoletus) in San Francisco Bay's Tidal Marshes - Is It Habitat Yet?

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The California Coastal Conservancy and U.S. Fish and Wildlife Service's San Francisco Estuary Invasive Spartina Project (ISP) has implemented four years of a five year program to rapidly enhance habitat for California Ridgway's rail (*Rallus o. obsoletus*) in areas affected by the invasion and subsequent removal of non-native Spartina. After successful removal of non-native Spartina, natural recruitment of some native species has been very successful

(e.g., perennial pickleweed, *Salicornia pacifica*). Our program has focused on planting two key components of rail habitat still missing at some sites, marsh gumplant (*Grindelia stricta*) and the native Pacific cordgrass (*Spartina foliosa*). One area in particular, the Eden Landing Ecological Reserve, has been a focus for reintroducing Pacific cordgrass. ISP and partners designed and installed plantings that aim to rapidly establish dense, strategically-located patches of vegetation that will benefit nesting, foraging and roosting rails as well as provide high tide refuge.

During the first four years of our program over 300,000 plants have been installed at over 40 sites by ISP and partners. Overall first-year survivorship for marsh gumplant planted during the first three years of the program was 31% (Year 1), 54% (Year 2), and 33% (Year 3). First-year survivorship for cordgrass was 40% (Year 1), 36% (Year 2), and 31% (Year 3). Marsh gumplant flowering, seed production, and the presence of new seedlings has been recorded at all sites indicating that the plantings are self-sustaining. For marsh gumplant planted in Year 1 of the program, we also measured plant volume, an indicator of the amount of critical taller cover available to rails. Planted cordgrass patches are rapidly expanding laterally, where prior to our planting efforts cordgrass was absent. In addition, we have recorded the presence of Pacific cordgrass seedling recruits in the vicinity of our plantings indicating successful seed production. Despite the ongoing drought, active revegetation has been successful in establishing critical cover for rails at restoration sites.

8. Lessons Learned from Restoring Solar Evaporation Ponds in the San Francisco Estuary.

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The goal of restoration is to reconstruct desirable ecosystem function believed to be important to target organisms or physical processes. In South San Francisco Bay approximately 15,100 acres of former salt evaporator pond was acquired in 2003 with a vision to restore salt marsh for wetland dependent biota. The adaptive management plan called for 7500 acres of managed/muted wetlands to be constructed at the Alviso, Ravenswood and Eden Landing marsh complexes. Documenting how the design of the managed ponds has impacted the physical conditions and biotic community is important to future restoration projects. In this study we measured water quality conditions with continuous water quality instruments in the pond A8 (5, 7, 8) complex and pond A16 in the Alviso Marsh. Muted-tidal ponds in the Alviso Marsh experienced persistent diel hypoxia from during the summer. Due to high phytoplankton production during daylight hours, dissolved oxygen (DO) concentrations in the A8 ponds often exceeded supersaturation (> 10mg/L). During low tides in adjacent Alviso Slough DO was typically much lower, however, conditions have actually improved in 2015 compared to previous years. This is likely the effect of highly oxygenated waters from pond A8, as 2015 was the first years that 5 of the 8 removable gates to pond A8 were open during the summer (2012-1 gate, 2013-14-3 gates). In 2015 fish assemblages in the pond A8 complex were similar to full-tidal ponds and adjacent slough habitats, suggesting the improved water quality conditions are supporting a healthy ecosystem. However, managed ponds also come with significant environmental regulation, higher management costs and adverse effects on fishes, including fish kills, entrainment of migratory species and mercury methylation. Thus managed pond restorations provide both positive and negative attributes for restoration and should utilized with caution in future restoration designs.

9. Record High Water Temperatures in San Francisco Bay, 2014–15

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Headline from 2014: “U.S. scientists have announced that the year so far has been the warmest on record, setting expectations for a long, hot, dry year ahead” (ClimateCentral.org). News reports across California called 2014 the

hottest year on record for the State as record high air temperatures were set across southern California while warmer winters made headlines in Northern California. Thus far, 2015 has shown no sign of cooling. Statewide air temperatures for January through March 2015 topped the 2014 record by 1.8°F, and air temperature at San Francisco International Airport recorded extreme values for winter months in both 2014 and 2015. Also making headlines, the Pacific warm blob is an unprecedented water temperature phenomenon occurring across the north Pacific; sea surface temperatures in 2014-15 were 3°C warmer than average. We analyzed water temperature measurements made by USGS from 1968-2015 to determine how the estuary has responded to these record-high winter air temperatures. We compared seasonal trends in the six major sub-embayments of the Bay-Delta system: Lower South Bay, South Bay, Central Bay, San Pablo Bay, Suisun Bay, and the lower Sacramento River. Results of monthly average water temperature from 1968-2015 show periods of record high temperatures estuarywide in 2014 and 2015, synchronous with record high air temperatures. Large deviations from the long term mean water temperature were seen across the Bay, notably, water temperatures in December 2014 were 4°C warmer. Warming of estuaries has important ecological implications, water temperature is an important habitat attribute, and is a strong regulator of metabolism and life cycles of biota from bacteria to fish.

10. South San Francisco Bay Shoreline Study – Phase I: Alviso Ponds and Santa Clara County

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The South San Francisco Bay Shoreline Study is a Congressionally authorized study by the U.S. Army Corps of Engineers together with the Santa Clara Valley Water District and the State Coastal Conservancy to identify and recommend flood risk management and ecosystem restoration projects along South San Francisco Bay for Federal funding. The partnership has completed its first study, which recommends a project in Santa Clara County that includes construction of an engineered levee to reduce flood risks to the community of Alviso and infrastructure serving Silicon Valley, tidal wetland restoration of former salt production ponds owned by the USFWS and City of San José, and public access features. If authorized by Congress, the project would protect a population at risk of approximately 5,500 residents and commuters and reduce flood risk to the San José-Santa Clara Regional Wastewater Facility and the Silicon Valley Advanced Water Purification Center. It would also restore approximately 2,900 acres of tidal marsh and transitional habitats, guided by monitoring and adaptive management, consistent with the South Bay Salt Ponds Restoration Project's regional efforts. The project would also create new connections in the San Francisco Bay Trail.

11. GreenPlan-IT: Quantitative Watershed Planning and Prediction for a Greener Urban Future

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Addressing stormwater runoff and pollution challenges associated with urbanization is complex and relies on costly engineering, especially in highly-developed urban environments. Increasingly, distributed management of stormwater runoff using Green infrastructure is emerging as a multi-benefit solution that can address both stormwater quality and quantity concerns. Consistent with this trend and under the NPDES Stormwater Municipal Regional Permit (MRP), many local municipalities are required to develop and implement watershed-scale green infrastructure plans to cost effectively achieve quantitative water quality improvements and provide reasonable assurance that Green Infrastructure will achieve the desired load reductions. As implementation of these green features ensues, over the lifetime of the South Bay Salt Pond Restoration Project, there will be changes to the supply or water, sediment and pollutants. What is the predicted magnitude of these changes and do they matter?

GreenPlan-IT, a watershed planning tool, was developed to support the cost-effective selection and placement of Green Infrastructure in urban watersheds and predict, through continuous simulation modeling, the resulting future changes to surface and groundwater flows and sediment and pollutant loads. The GreenPlan-IT ToolKit is

comprised of three Modules: a GIS-based Site Locator Tool, a Modeling Tool, and an Optimization Tool. It utilizes local knowledge, sound science, and engineering principles to systematically identify and map feasible and cost effective locations for green infrastructure in relation to locally set goals. The Modeling Tool is built on a spatially distributed hydrologic and water quality model called SWMM. It is used to understand current baseline conditions (spatial distributions of ground water infiltration, flood flow runoff volumes and sediment and pollutant loads). It is also used to simulate future flow and loads conditions (with reasonable assurance) in relation to the cost optimal scenarios (the locations, types, and design configurations for Green Infrastructure that minimize the total development/redevelopment cost while satisfying water quality and flow objectives within local constraints) determined through the optimization module. The tool development is largely completed and the tool is available for download from a dedicated web site (http://greenplanit.sfei.org/) where you will also find supporting user documentation.

12. Response of waterbirds to island creation within an estuarine ecosystem

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Thousands of migratory and wintering waterbirds roost and forage within the San Francisco Bay Estuary and rely on habitat in former salt production ponds. In particular, shorebirds tend to use these ponds for roosting and additional foraging opportunities at high tide when adjacent mudflats are inundated. The South Bay Salt Pond Restoration Project plans to restore 50-90% of ponds to tidal marsh while maintaining waterbirds in a smaller footprint of managed ponds. Thus, in 2009-2010, the restoration project constructed 30 islands of two different shapes in Pond SF2. To assess the response of waterbirds to these islands, we conducted weekly surveys from October to May 2010-2012. We used a Geographic Information System to measure island spatial characteristics, including island shape, elevation, slope, and island distance to the highway, the adjacent mudflat, the nearest levee, and the nearest island. We modeled waterbird abundances on islands using generalized linear mixed models. We created a candidate set of models and we compared model results using AIC. We observed 262,932 birds across our study, of which 14% used the islands. Islands supported a higher abundance of small and medium shorebirds, piscivores, gulls and dabbling ducks at high tide compared to low tide. Islands farther from other islands supported higher abundances of medium shorebirds, piscivores, gulls, and dabbling ducks. Islands with a smaller slope and a higher elevation supported higher abundances of small shorebirds than did steeper and lower elevation islands. Island farther from the pond levees supported a higher abundance of dabbling ducks compared to islands closer to pond levee. Island shape was only significant for gulls, with a higher abundance of gulls on linear islands. Our research highlights immediate waterbird use of constructed islands and identifies island characteristics that support higher bird abundances. An understanding of island use by birds is important for guiding future island construction in future restoration efforts within the ponds.

13. Characterization of and potential mechanisms for low dissolved oxygen in the sloughs of San Francisco Bay

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The southernmost portion of San Francisco Bay (SFB), Lower South Bay (LSB), is a collection of deep and shallow sub-tidal habitats, intertidal mudflats, and a large area of wetlands undergoing restoration that exchange with the open Bay via a number of shallow sloughs. Dissolved oxygen (DO) has historically been monitored 1-2x monthly in the deep channel of LSB, and has typically been 6-8 mg/L despite high nutrient inputs to LSB. However, recent high-frequency data demonstrate that DO in the deep channel can dip below 5 mg/L, with minimum DO regularly occurring at lowest tides in summer months. We hypothesized that this DO drop was caused by exchange of low DO water from sloughs and wetlands along the LSB periphery. These regions have not been systematically

monitored to date, but initial observations at one moored slough station showed that DO frequently dropped below 5 mg/L and reached concentrations as low as 2-3 mg/L, and that the severity and duration of those low-DO events was strongly related to both semi-diurnal tides and the spring/neap tidal cycles. In this project, we established a network of continuous sensors at slough and open channel sites and also collected high-spatial resolution data and vertical profiles to answer the following questions: (1) How do and chl-a concentrations in slough habitats vary in space (along channel and vertical) and in time (tidal to seasonal time scales)?; (2) What are the severity, extent and duration of low-DO events, and what are controlling mechanisms (i.e., organic matter exported from wetlands vs. in situ respiration)?; and (3) How does exchange with sloughs and wetlands affect open Bay conditions? This poster will present our findings from the first spring and summer of observations.

14. Benthic response to water quality and biotic pressures in lower South Bay-Alviso-Coyote Creek

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Benthic communities are monitored because they reflect the water quality over their lifetime, in some cases these communities may control available carbon resources, and are common prey for birds, larger invertebrates and fish. Benthic communities monitor stressful environments because they are stationary, accumulate contaminants, and respond, sometimes dramatically, to low and high phytoplankton biomass as well as low oxygen conditions. Benthic communities can also affect water quality by grazing pelagic food resources and increasing the rate of nutrient regeneration through feeding and bioturbating the sediment. South Bay is a system dependent on phytoplankton as the base to the food web. Despite abundant nutrients, South Bay has limited phytoplankton production in the last several decades due to poor light conditions and high grazing losses. Our primary objective is to characterize the South Bay's benthic community to determine if the observed changes can be attributed to water quality or biological pressures.

We analyzed the benthic community's species and functional composition. This analysis incorporated samples collected from Coyote Creek in 2009-2014 and Guadeloupe Slough, Alviso Slough, and Artesian Slough in 2014. The Coyote Creek Benthic community data showed a transition in the numerically dominant species, from bivalves in 2009- fall 2013 to amphipods in fall 2013-2014.

While amphipods and bivalves were both present year round in Guadeloupe and Alviso sloughs, amphipods were numerically dominant in the early months of 2014 and bivalves were the numerical dominant during the summer of 2014. Changes to the numerically dominant species in the lower South Bay and the associated Sloughs represent changes in prey species and hence food quality to predators. We acknowledge support from San Jose-Santa Clara Regional Wastewater Facility for funding this project.

15. Habitat Island Surface Treatments

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Islands in San Francisco Bay provide habitat for a myriad of waterbirds. However, it can be difficult to provide persistent high quality habitat without continuous maintenance. In order to seek solutions to cracking, vegetation, and erosion problems, test islands were constructed at Eden Landing Ecological Reserve. Five different surface treatments were installed on test islands and their physical and chemical properties were studied. Lime was chosen as the selected surface treatment and installed on four of the six nesting islands. Unique construction techniques were utilized to perform this work in soft marsh soil conditions.

16. A Scientific Data Drone for Environmental DNA (eDNA) Sampling

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Rapid species identification of aquatic ecosystems is a critical and valuable undertaking in terms of ecosystem management and invasive species mitigation. Collecting water samples from rivers, lakes and ponds in the most efficient and cost effective manner is an important component of this research. Currently, the main method of species identification is achieved through the collection of water samples that are then transported to a lab and filtered. From those samples, environmental DNA (eDNA) is extracted. In general, this is a costly and time consuming method. In our work, an intelligent water collecting payload is presented and verified through experiments, leveraging the numerous advantages of unmanned aerial systems (UAS). The water collecting system improves upon current sampling methods in that the operator remains on the shore, rather than physically collecting water samples manually, while the UAS lands on the surface of the water. The payload then samples and filters the water, in-situ, thus shortening the turn around time from sample collection to species identification.http://mechatronics.ucmerced.edu

17. A Scientific Data Drone Payload for Bioaerosol Collection

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Coccidiodomycosis, or Valley Fever, is a debilitating fungal disease contracted through the inhalation of Coccidiodes immitis and Coccidiodes posadasii prevalent in the southwestern United States and northern Mexico. Recent studies show that there is an increase in the number of incidence throughout these regions, not excluding the San Joaquin Valley (SJV). While there are many reported cases of the disease, how the fungus is transported through the atmosphere is not well known. This is due in part to the fact that there is no effective and reliable standardized method for acquiring fungal spores at an elevated altitude. Additionally, rapid detection of bioaerosol pathogens, such as Valley Fever, can aide in the public awareness and rapid response of public health officials to notify nearby communities to stay indoors or wear protection. This project aims to fill the voids of sensing capability and rapid detection by means of small unmanned aerial systems (UAS), or aerial vehicles that have a maximum takeoff weight of 25 kg or less. The use of small UAS allows for samples to be taken from zero to 500 feet, lower than manned aircraft, and the low-cost development and operation of the payload. The payload consists of two main components: a physical sample filtration sub-system and an analog sensor suite. These units are coupled together to log critical data during the flight and are easily analyzable in post-processing. The physical sample filtration sub-system yields a single filter that is re-suspended and analyzed on a flow cytometer and cultured. This method is used to validate the effectiveness of current sampling methods, and current work is being conducted to develop a “field-kit” for bioaerosol detection. http://mechatronics.ucmerced.edu.

18. Shorebird response to varying salinity and water depth in an experimental design in salt pond management

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San Francisco Bay Estuary supports thousands of shorebirds during fall and spring migration and over winter. These shorebirds rely on foraging opportunities in the bay mud flats and former salt production ponds. The South Bay Salt Pond Restoration Project plans to restore 50-90% of salt ponds to tidal marsh and the resulting sediment demand for restoration may reduce the extent of remaining mud flat. Ponds E12 and E13 in the Eden Landing

Ecological Reserve were enhanced to provide varying levels of salinity and water depth for increased shorebird foraging and roosting opportunities. Each pond was divided into three cells and foraging mounds were constructed to provide variation in topography. Our objectives were to understand shorebird use and invertebrate colonization immediately post-construction. We surveyed shorebirds across the cells and within survey plots on foraging mounds during the first winter (Jan-April) post-construction. We measured water quality and collected benthic macro-invertebrate cores and sweep samples on the mounds. Small shorebirds, predominantly Western Sandpiper and Dunlin, were the most abundant shorebirds, with over 5,000 observed across all cells each month. Small shorebird abundance on foraging mounds ranged from zero to several hundred; however only 10% were observed foraging. We found aquatic invertebrates in our sweep samples and primarily ostracods in our sediment cores; however, we expect additional colonization to occur over time. Our research highlights immediate shorebird use of managed ponds manipulated to provide suitable water depths for roosting and foraging opportunities. Our on-going studies at these experimental ponds will increase our understanding of shorebird spatial distribution in relation to water salinity, depth, and invertebrate composition, and will provide managers with key information to optimize ponds for wintering and migrating shorebirds.

19. A Test of Educational Methods to Reduce Boater Disturbance to Harbor Seals

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Wildlife managers view educating the public as a key strategy for reducing the negative impacts of public access and recreation on wildlife. Environmental education can affect attitudes and behaviors, but determining the most effective methods for protecting wildlife requires research. This study examined the effect of two modes of environmental education, interpretive signage and docents, on the behaviors of boaters toward harbor seals (Phoca vitulina) at Corkscrew Slough in Redwood City, California, an area where harbor seals haul out and pup. Thirty-one boaters viewed an interpretive sign and 30 experienced a docent talk, both designed to educate boaters on protecting harbor seals; 31 boaters received no environmental information (the control). Data were collected on how these boaters responded to harbor seals in Corkscrew Slough and on the response of harbor seals to the boaters. Boaters exposed to signs or docents stayed significantly further (47 m and 48 m, respectively) from the seals compared to boaters not exposed either form of environmental education (32 m). However, neither the signage nor the docent reduced the length of time (4.91 min and 3.53 min, respectively) boaters spent traveling through the Slough compared to the control (2.80 min). Nor did either educational approach reduce the number of boaters stopping to observe seals. On average, 90% of harbor seals remained at rest, 10% were alert, and 1% flushed when no boat was present in the Slough. Harbor seal alert and flush rates increased significantly in response to boaters, no matter what the mode of education for the boaters. These results suggest signs and docents may change some boater behavior, but that managers should not depend solely on these educational approaches to protect sensitive wildlife.

20. Wetland Microbial Community Response to Restoration

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Wetland restoration has been proposed as a potential long-term carbon storage solution, with a goal of engineering geochemical dynamics to accelerate peat accretion and encourage greenhouse gas (GHG) sequestration. However, wetland microbial community composition and metabolic rates are poorly understood and their predicted response to wetland restoration is unknown. In an effort to better understand the underlying factors that shape the balance of carbon flux in wetland soils, we targeted the microbial communities along a salinity gradient ranging from freshwater tidal marshes to hypersaline ponds in the San Francisco Bay-Delta region. Using 16S rRNA gene sequencing and shotgun metagenomics, coupled with greenhouse gas measurements, we sampled sixteen sites capturing a range in salinity and restoration status. Seawater delivers sulfate to wetland

ecosystems, encouraging sulfate reduction and discouraging methane production. As expected, we observed the highest rates of methane production at the lowest salinities. Recently restored freshwater wetlands in the SF Bay Delta region had significantly higher rates of methane production compared to their historic counterparts, rates that could be attributed to variations in trace metal and organic carbon content in younger wetlands. In contrast, reconnection to the Bay resulted in a rapid return of indigenous microbial communities and a decrease in methane production in restored, former industrial salt ponds. Notably, we found elevated methane production rates in unrestored hypersaline ponds, the result of methylotrophic methanogen activity, as confirmed by both DNA sequencing and culture work. Our study links belowground microbial communities and their aboveground greenhouse gas production and highlights the inherent complexity in predicting wetland microbial response in the face of both natural and unnatural disturbances.

21. Estuarine-Terrestrial Transitional Plant Community Creation Research

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Plants readily colonize strongly intertidal areas once restoration earthwork is complete, but for various reasons vegetation colonization of weakly-tidal high marsh and upland transitional habitats is poor, so they require active management techniques to ensure high quality habitat develops. SFBBO Habitats ecologists have been researching the management of these habitat's plant communities for 7 years, through a continuing series of applied research projects. Since 2007, we have developed a list of around 50 species that were likely once present in habitats adjacent to the estuary. We have searched for, collected, processed and tested 30 of these species through direct seeding using every suitable method. Our current suite of testing sites includes upland fill soils, as well as newly and historically-dredged estuarine spoils. Applied testing at these sites will occur at least over the next five years, allowing us to further refine the methods and materials needed to create functional plant communities using locally-native plants.

22. California Gull Population Growth and Response to South Bay Salt Pond Restoration

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Since 1980, the San Francisco Bay Bird Observatory (SFBBO) has surveyed California Gull breeding colonies throughout the South Bay. This monitoring has documented a rapidly increasing population from only 24 birds in the early 1980s to over 50,000 in 2014. This past season, in 2015, we estimated a decline to just under 48,000 breeding California Gulls. Over the 30 years of California Gull population growth, SFBBO and others have also documented declines in populations of many shorebird and tern species in the region, including the federally-threatened Western Snowy Plover. Scientists at SFBBO, the USFWS and the US Geological Survey have shown that California Gulls consume the eggs and chicks of shorebird and tern species. Therefore, the rapid growth of California Gulls has been identified as one of the most pressing concerns for management of the San Francisco Bay Estuary by SFBBO, by federal and state agencies charged with managing this ecosystem, and by the South Bay Salt Pond Restoration Project.

In this poster, we will highlight California Gull population growth at all colonies across the South Bay and present band re-sighting data, focusing on gull movement in response to restoration of Pond A6. Information on gull population growth and how gulls respond to restoration activities helps land managers predict gull response and manage adaptively to the future restoration of 15,000 acres of salt ponds in South San Francisco Bay.

23. Flood Protection Provided by the Salt Ponds and Slough Geometry Response to the Pond A8 Notch

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The Santa Clara Valley Water District has an interest in understanding the flood protection benefits provided by the salt ponds. The District has conducted a two-dimensional hydrodynamic modeling study to delineate the 1% coastal floodplain with the existing salt ponds in place. This will be compared with a map based on modeling conducted assuming the no-ponds case to show the maximum flood protection benefit provided by the salt ponds. The poster will also provide information about how the construction of the Pond A8 notch in 2010 has altered the cross section geometry of Alviso Slough in response to the increased tidal prism.