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Poster Abstracts

October 10-11,

2017

Abstracts for posters presented at the 2017 State of the San Francisco Estuary Conference are compiled in this document. Abstracts are listed by Poster Topic. Though many posters have multiple authors, only the presenting author is listed in the table of contents.

In the abstracts, names of presenting authors are underlined. Asterisks (*) indicate the poster is submitted by a student and eligible for the student poster awards competition.

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A Fifty-Year Plan to Integrate Multi-Functional Green Infrastructure in Walnut Creek Watershed

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Our research partnership between UC Berkeley and Contra Costa County Flood Control and Water Conservation District defines a framework for identifying opportunities to integrate multi-functional green infrastructure into existing urban development. As cities, counties and flood control districts seek to replace aging, single-purpose "gray" infrastructure with multi-functional green infrastructure, existing development limits options to restore natural, self-sustaining creeks. Strategies for integrating cost-effective green infrastructure into existing development must consider underlying biophysical conditions that support natural processes. Our presented case study from Walnut Creek Watershed explores the ecological and social potential of creek restoration within a watershed context and develop strategies to overcome constraints and reconfigure land use to support multiple community needs.

We used suitability analyses to target areas that can serve specific watershed functions: creek conveyance, seasonal storage, and infiltration for groundwater recharge. We mapped reach-based benefits and parcel-based opportunities for creek restoration and floodplain expansion, then considered their intersection to develop recommendations for short-term versus long-term planning strategies. Our delineation of reach-based benefits was informed by a literature review that sought evidence and quantification of "services" that stem from watershed functions of creek corridors, expanded floodplains and infiltration zones. Our parcel-based analysis maps allowed us to identify and classify restoration strategies based on parcel, stakeholder and spatial relationships.

Resulting maps informed development of six planning strategies to support project goals: define and prioritize a roadmap of restoration steps, build a stakeholder network, pursue integrative policy approaches across a hierarchy of jurisdictions, communicate and negotiate objectives and timelines, and inform decision-making with economic and hydrologic models that consider multiple across a range of implementation scenarios. Our proposed framework and strategies can help align community stakeholder interests, policy agendas and planning efforts toward effective implementation of multi-functional green infrastructure and investment in creeks, floodplains and watersheds as community resources.

Keywords: green infrastructure, watershed, restoration, water quality, community benefits

Poster Cluster Title: A Fifty-Year Plan to Restore Aquatic Ecosystems with Green Infrastructure in Walnut Creek Watershed

Infiltration Suitability Mapping for Cost-Effective, Watershed-Scale, Community-Based Green Infrastructure

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Current approaches to urban creek restoration often employ opportunistic, site-based management resulting in isolated stream reach restoration that do not consider the context of the former floodplain, upstream contributing watersheds and community needs. Planning for and realizing a healthy watershed requires watershed-scale suitability mapping to recognize and address the impacts of urbanization on water as it cycles through a watershed. To address this gap in watershed management and urban creek naturalization, our UC Berkeley research team developed a geospatial framework for identifying priority areas for green infrastructure. Using Grayson Creek Watershed, a subwatershed of Walnut Creek, in Contra Costa County as a case-study, we combined feasible locations for stormwater infiltration throughout the watershed to support ecological restoration of creek channels.

Our results indicate that limited opportunities exist for shallow surface infiltration due to low permeability soils, liquefaction, and steep slopes; however, permeable quaternary deposits present opportunities for deep stormwater infiltration throughout the watershed where shallow infiltration may be infeasible. These shallow infiltration and deep infiltration areas can support infiltrating green infrastructure to treat stormwater runoff, increase groundwater recharge, and reduce peak flows in the watershed, and can be paired strategically with high priority channel reaches to further improve ecological benefit for restored salmonid populations through improved water quality, increased base flows and cooler water temperatures. These infiltration priority areas can be incorporated into green infrastructure planning and creek restoration initiatives by identifying parcels and engaging land owners with capacity to support implementation and participate in demonstration projects. Our strategic approach to green infrastructure planning can be transferred to other watersheds and serves as a new tool for landscape architects, environmental planners, and flood control districts seeking to restore self-sustaining creek corridors through a watershed-scale approach.

Student Award Competition: Yes

Keywords: Infiltration, creek naturalization, suitability mapping, urbanization, flood management, community need

Poster Cluster Title: A Fifty-Year Plan to Restore Aquatic Ecosystems with Green Infrastructure in Walnut Creek Watershed

Land-Use Planning, Policy and Precedents for Integrating Green Infrastructure in Suburban Watersheds of SF Bay

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Private parcels dominate Bay Area watersheds. Existing development along creek centerlines, within floodplain corridors and over the most suitable locations for infiltration presents a challenge to planning and implementation of creek restoration and green infrastructure. In 1999, the Contra Costa County Flood Control and Water Conservation District (District) defined and adopted a "Fifty-Year Plan" to prioritize concrete channel removal, creek restoration, and floodplain expansion in the District's capital replacement plans. Our poster will explore land use mechanisms to support implementation of this long-term vision within a watershed-scale, green infrastructure framework based on an analysis of opportunities and constraints within the Walnut Creek Watershed of Contra Costa County.

Walnut Creek Watershed creekside and floodplain parcels range from small and numerous suburban residential lots to large commercial holdings that generate sales tax revenue for municipalities. Local flood control channels protect these encroaching properties, reinforce expectations of permanent flood protection, and lie enmeshed in the constraints and opportunities of Bay Area land-use issues. To address these constraints, we inventory and explore potential land-use ordinances, land acquisition programs, funding strategies, and integrated planning efforts based on anticipated needs and a wide-ranging survey of precedent studies. Our poster will present a curated set of relevant land use planning and policy mechanisms, explain how they work, where they have been implemented, and pros and cons of their potential integration into policies and programs to support green infrastructure planning and implementation in the Bay Area.

Student Award Competition: Yes

Keywords: Land use, policy, ordinances, special districts, green infrastructure, flood management

Poster Cluster Title: A Fifty-Year Plan to Restore Aquatic Ecosystems with Green Infrastructure in Walnut Creek Watershed

Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

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Recent research on the salt marsh harvest mouse (*Reithrodontomys raviventris*) has greatly improved our understanding of the ecology of the mouse and our abilities to effectively manage it. Modern research techniques such as genetic analyses and powerful statistical analyses are providing managers with valuable new information that allows us to understand the status of populations of mice throughout the Estuary. Additionally, many of the knowledge gaps that exist in our understanding of the life history of the species have recently been addressed. Armed with these new tools and new data, managers are now more prepared to tackle some of the challenges they will face in conserving this endangered species in the face of future threats such as climate change and associated sea level rise. In this poster cluster we provide an overview of some of recent improvements to research and management techniques, and present data that will aid in the future management of the species.

Student Award Competition: Yes

Keywords: salt marsh harvest mouse, genetics, statistical analysis, management, conservation, habitat

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

The Salt Marsh Harvest Mouse (SMHM; *Reithrodontomys raviventris*) Workgroup: Identifying Recovery Needs and Data Gaps

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The Salt Marsh Harvest Mouse (SMHM; *Reithrodontomys raviventris*) is a federally and state endangered species endemic to a variety of marsh habitats in San Francisco Bay. Despite several pivotal studies conducted in the 1960-1980's there remains a general lack of understanding about their ecology, genetics, and long-term trends. A SMHM workgroup was initiated to facilitate coordination and standardize measurement protocols and identification techniques. This group also serves to inform the Tidal Marsh Recovery Implementation Team, and is comprised of State, Federal, University, and NGO partners/collaborators. In 2016 the Workgroup established 3 priority working groups to help address priority needs: 1) develop a standard suite of protocols, 2) a uniform database, and 3) identify SMHM recovery needs.

Keywords: endangered species, standard protocols, database

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Salt Marsh Harvest Mouse Survey Bias, New Results for China Camp State Park

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China Camp State Park is within the range of the Northern subspecies of the salt marsh harvest mouse (*R. raviventris halicoetes*). New information on vegetation and habitat use by salt marsh harvest mice has been published, particularly from work done in the Suisun Marsh. However, many surveys focus on tidal marshes dominated by pickleweed (*Salicornia pacifica*) and salt marsh harvest numbers captured can be very low. In the Suisun Marsh surveyors take into consideration vegetation height, thatch layer, and structure of vegetation when selecting survey locations. In August 2014 the Department of Fish and Wildlife and the Department of Water Resources conducted a survey at China Camp State Park. We targeted two muted tidal marshes west of Turtle Back Hill which had taller vegetation and were not inundated during high tides. These marshes had never been surveyed as North San Pedro Road was considered a barrier for the mouse. Over three nights a total of 21 individual salt marsh harvest mice, 11 western harvest mice (*R.megalotis*), 8 voles (*Microtus californicus*), 8 deer mice (*Peromyscus maniculatus*), and 6 house mice (*Mus musculus*) were captured. We believe our surveys show that larger numbers of salt marsh harvest mice are present at China Camp than previous survey efforts found. Future survey efforts should not be limited to pickleweed and should include tall vegetation and muted tidal wetlands as these types of wetlands may be all that remain as tidal areas become flooded out due to sea level rise.

Keywords: salt marsh harvest mouse, *Reithrodontomys raviventris*, muted tidal, China Camp

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Nest Variation in the Salt Marsh Harvest Mouse Offers Potential Resilience to Climate Change

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For 3 years researchers conducted radio telemetry on the northern subspecies (*Reithrodontomys raviventris halicoetes*) of the salt marsh harvest mouse. Through the course of the study, researchers often located mice in nests. The nests came in many varieties, both in nesting material and nest locations. The variation in nests suggests the salt marsh harvest mouse may not be as specialized as previously believed. This offers a glimpse of hope for the salt marsh harvest mouse's ability to adapt in the face of climate change.

Keywords: Endangered, Climate Change, Salt Marsh Harvest Mouse

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Drivers of Longterm Trends for Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*) at Crescent Unit, Suisun Marsh

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Federally and CA State endangered salt marsh harvest mouse (SMHM, *Reithrodontomys raviventris*) is endemic to marshes and adjacent habitats in the San Francisco Bay and Delta. Despite several pivotal studies conducted in the 1960-1980's there remains a general lack of understanding of population trends and variability marsh habitats. Here, we examine a long-term dataset to understand population trends, and compare population estimates with capture indices for SMHM. We also examined potential drivers of population trends, including physical (weather, temperature, inundation patterns, rainfall) and biological parameters (vegetation). From 2000-2016 small mammal surveys were conducted by CA Dept. Fish and Wildlife at Crescent Unit, Grizzly Island Wildlife Area in Suisun Marsh. Crescent Unit is an extensive marsh which receives most of its water in the form of precipitation, as water management is minimal, and the area is not fully tidal. Vegetation is predominantly pickleweed (*Salicornia* spp) with some annual grass and bare ground due to salt scalding. Small mammal surveys were conducted annually and each SMHM captured was given a unique fur clipped pattern to distinguish individuals. Since the SMHM recovery metric uses a capture index, we compared this to mark-recapture population estimates. In general, the capture index and population estimates had similar patterns of population fluctuations. Winter through early spring precipitation had the strongest correlation to SMHM abundance for the following summer (June), indicating that increased precipitation during the winter and spring time periods resulted in decreased population abundance. Other parameters such as inundation, temperature, and vegetation did not have a strong correlation on SMHM population abundance.

Keywords: endangered species, mark-recapture, population estimate, capture index, abundance

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Characterizing Adaptive Immunogenetic Variation in the Endangered Salt Marsh Harvest Mouse, *Reithrodontomys raviventris*

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Adaptive genetic loci reflect selective responses to environmental variation that may be critical to population and species survival, while neutral loci reflect the influence of general demographic effects. Neutral loci are often used to characterize endangered populations, forming the basis of conservation plans; however, it is also important to consider functional adaptive loci, such as immune system loci at the major histocompatibility complex (MHC). As the most variable loci in vertebrate genomes, MHC can provide detailed information on population distinctions and viability. In this first study of adaptive genetic diversity in the salt marsh harvest mouse, we sequenced the MHC Class II DRB locus. Hair from mice was collected from 12 sites across Suisun, San Pablo, and San Francisco Bays. DNA from individuals was cloned and sequenced at the functionally diversifying MHC locus (n=56) and sequenced at the functionally conserved mitochondrial cytochrome b locus (cytB, n=104), used as a neutral reference locus. Patterns of genetic diversity show regional differentiation at both loci, particularly between northern and southern regions, corresponding to subspecies designations. In the southern subspecies, patterns of genetic diversity between MHC and cytB are similar, while in the northern subspecies MHC is more diverse. Northern populations are functionally differentiated at the MHC locus with six unique alleles as compared to only one in southern populations. Selection tests indicate positive selection acting on the MHC locus (dN/dS=6.29, p=0.006 at antigen binding sites), suggesting that there is still enough diversity at this locus to respond to selection. However, supertype analysis (based on binding sites under positive selection) shows that southern populations have only half the supertype diversity found in northern populations, indicating limited adaptive potential. We recommend adaptive immunogenetic data be used along with neutral genetic data to prioritize conservation efforts and most effectively manage and recover endangered species.

Keywords: immunogenetics, conservation genetics, endangered species, adaptive genetic variation, habitat fragmentation

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Managing the Salt Marsh Harvest Mouse in the Built Environment

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Worldwide, about 50% of wetlands have been lost. In the San Francisco Bay Estuary (SFBE) less than 10% of historical tidal wetlands remain, and those comprise a fragmented mosaic of natural and anthropogenically altered wetlands. Globally, only 5 species of vertebrates, and only one mammal, the endangered salt marsh harvest mouse (SMHM, *Reithrodontomys raviventris*), are restricted to coastal wetlands. SMHM is a unique wetland-adapted rodent endemic to the marshes of the SFBE. Conventional conservation practices have favored a push toward tidal restoration as a recovery action for SMHM. However, tidal wetlands are vulnerable to sea level rise and tidal restoration is slow and costly. Understanding and maximizing the value of alternative habitat types can improve conservation of SMHM. We investigated the relative value of historical tidal and anthropogenic diked wetlands for SMHM. We found that both support similarly sized populations and similar numbers of reproductive females, but diked wetlands had higher densities of juveniles. Habitat use is similar between wetland types, home ranges are not significantly different and microhabitat use was similarly flexible. Finally, preferred food plants occur at high densities in diked wetlands. This study – the first of its kind – greatly improves our understanding of the habitat requirements of SMHM. Diked wetlands have high habitat value for SMHM, possibly superior to tidal habitat; this result triples the acreage of "good" SMHM habitat in the SFBE. It also illustrates the importance of understanding the value of anthropogenic habitats for conservation of endangered mammals as historical habitat patches dwindle.

Student Award Competition: Yes

Keywords: salt marsh harvest mouse, managed wetlands, tidal restoration, habitat management

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Diet Preferences of the Salt Marsh Harvest Mouse

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Historically it was assumed that Salt Marsh Harvest Mice (*Reithrodontomys raviventris*, SMHM) ate predominately pickleweed (*Salicornia pacifica*) and therefore were only found in habitat with pickleweed. However, based on the cafeteria trials of local species performed during this diet study, the data collected suggests that they actually eat a wide range of food, including invasive and non-native species. Some of the most consumed species in the study were non-native, showing that the salt marsh harvest mouse can be very adaptive when it comes to its food requirements. This study suggests that a change in criteria for the species' habitat requirements is necessary. They can and are found in areas without pickleweed which was incorrectly thought to be necessary for viable habitat. New habitat and/or potential habitat destruction could be managed better if the habitat criteria were expanded to include areas without pickleweed.

Keywords: SMHM, Salt Marsh Harvest Mouse, Pickleweed, invasive, conservation, management

Poster Cluster Title: Conserving the Endangered Salt Marsh Harvest Mouse in the Modern San Francisco Estuary

Changing Sense of Place in the Sacramento-San Joaquin Delta

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Current legislation regarding the management of the Delta region mandates that decisions take into account “a sense of place.” The definition of “place” has evolved as the Delta has become home to different immigrants over more than 10,000 years. The ways in which inhabitants have defined their environment provides context by which to understand attempts to reshape the Delta to better suit their needs. Shifts in a sense of place are reflected in the cycle of reclamation and restoration, in the development of technologies to tame nature, in the rise and fall of towns, and in the tensions manifest in artistic endeavors. A timeline of Delta history reflects these shifts and demonstrates how place matters. This narrative also documents significant struggles between human habitation and the force of nature; an enduring theme in American history.

Keywords: Place, historical cycles, immigration, nature

Poster Cluster Title: Delta Narratives: The History and Culture of the Sacramento-San Joaquin Delta

Managing the Garden: Agriculture, Reclamation, and Restoration in the Sacramento San Joaquin Delta

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To increase agricultural productivity, beginning in the second half of the nineteenth century a complex system of levees was constructed in the Delta. However, flooding and salinity intrusion continued to be a threat to agriculture and community life. During the 1930's and 1960's ambitious reclamation projects were undertaken by both the state and federal governments. As a consequence the Delta has been "reorganized" by pumps and aqueducts to provide water for the southwestern portion of the Central Valley and metropolitan Southern California. In the struggle to re-allocate water between growing cities and expanding farms, the unique habitats of the Delta have been threatened. Since the waterways also support boating, hunting and fishing, the recreational community has become increasingly engaged. One result has been the creation of a series of preserves to respond to dislocations caused by reclamation.

Keywords: Reclamation, Restoration, Habitat, Levees, Water

Poster Cluster Title: Delta Narratives: The History and Culture of the Sacramento-San Joaquin Delta

Stitching a River Culture: Trade, Transportation and Communication in the Sacramento San Joaquin Delta

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By the mid-19th century, steam powered water transport tamed the region, creating docks and warehouses. The Delta was also restructured as bridges carrying trains and trucks increasingly replaced boats to facilitate the movement of people and goods. Factories rose and fell, processing agricultural goods and building farm machines. Key technological changes here were based on the advent of electricity and the internal combustion engine. The result was innovation, including tractors and specialty boats required to exploit the Delta environs. In fact, in the early 20th century, the Delta and its surrounding cities (San Francisco, Stockton, and Sacramento) evolved into a "silicon valley" in the service of agriculture, inventing and refining equipment later used worldwide for planting, harvesting, packing, and transporting a wide range of crops.

Keywords: Boats, Rail, Trucks, Agricultural Technology

Poster Cluster Title: Delta Narratives: The History and Culture of the Sacramento-San Joaquin Delta

Literature and Visual Arts of the Delta, 1849-1975

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America has been envisioned in Biblical imagery as a place where God has made a good life possible but also where the weaknesses of human endeavor are prophesized. The reality of the Delta experience has provided writers and artists the opportunity to test that hypothesis. 19th and early 20th century writers showed California as an El Dorado where Anglos in particular could find riches. As one moves into the 20th century, others, like Jack London, see struggles over wealth in California, but also material for the imagination and for adventure. Mid-20th century poets like William Everson have praised the subtle natural elegance of the landscape even after reclamation. Joan Didion, however, captures the dark side of pursuing the American Dream, writing about the dependence of the Delta on monolithic financial structures outside the control of local residents. A striking contrast between viewing the Delta as a promised land and as a prophetic warning of human abuse arises from the work of John Ross Key in 1860 and of Wayne Thiebaud in 2000.

Keywords: Literature, Painting, American Dream, Rape of Nature

Poster Cluster Title: Delta Narratives: The History and Culture of the Sacramento-San Joaquin Delta

Progress Toward Eradicating Invasive Spartina from the San Francisco Estuary – 2005-2016

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The State Coastal Conservancy and the U.S. Fish and Wildlife Service undertook the San Francisco Estuary Invasive Spartina Project in 2000 in response to the rapid spread of non-native Spartina in tidal marshes of the San Francisco Estuary. In 2005, after five years of planning and permitting, a coordinated regionwide eradication effort was underway. Control in the first several years was effective and dramatic, with a peak baywide net area of 805 acres in 2005 being reduced by 90%, to 84 acres by 2010. The net area has continued to decrease steadily to 27 acres in 2016, despite suspension of treatment at 11 sites in 2011 (see associated California Ridgway's Rail poster).

While the total net area of non-native Spartina declined steadily, local and regional changes were variable. Very rapid progress was made in reducing dense populations in the Central and South bays between 2005 and 2010, and this trend was continued through 2016. Populations of greater than one acre remain only at the 11 sites in this region where treatment was suspended. Over this same period, new non-native Spartina populations established, expanded, were discovered, and were subsequently brought under control in regions of the North Bay, Petaluma River, and in estuaries on the outer coast. In 2017, a new outlier population, totaling about 0.5 net acre, was discovered on several islands in Suisun Bay. Treatment will be initiated on the Suisun population this summer.

Keywords: Spartina, invasive, eradication, Conservancy, Ridgway's rail

Poster Cluster Title: Invasive Spartina Project Updates

California Ridgway's Rail Survey Results at *Spartina*-invaded Marshes from 2010 to 2017 and the Implications for Eradication of Invasive *Spartina* from the SF-Bay Estuary

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The State Coastal Conservancy's Invasive *Spartina* Project (ISP) reduced invasive *Spartina* in the San Francisco Estuary by 95% between 2005 and 2012. During this time, the number of endangered California Ridgway's rails (*Rallus obsoletus obsoletus*), which uses invasive *Spartina* for cover and nesting substrate, declined substantially at these sites. By the end of 2010, most invasive *Spartina* populations in the Bay had been reduced to insignificant levels and no longer provided cover for clapper rails. In fall of 2011, treatment of invasive *Spartina* was suspended at ten marshes in the East Bay, due to concerns over the declines. The ISP and partner agencies determined that greater than 915 rails must be detected for three consecutive years at a set of consistently surveyed sites before consultation and planning for treatment of the ten suspended marshes could be re-initiated.
Between 2012 and 2017, invasive *Spartina* increased in the marshes where treatment was suspended, but it declined bay-wide. During this period, rail numbers increased—in marshes where invasive *Spartina* treatment was suspended, in marshes where invasive *Spartina* persists and is annually treated, in marshes that have little to no infestation impact, and in younger restoration marshes that are maturing with predominantly native vegetation to support the rails. Results from 2017 rail surveys show that the three-year threshold of 915 rails has been met, and more than 1,200 birds were detected at consistently surveyed sites. The ISP will continue to work with partners and regulators to develop treatment plans for these sites in a fashion that achieves the goals of both endangered species management and landscape level invasive plant eradication.

Keywords: Tidal marsh, spartina, invasive, Ridgway's rail, endangered, Rallus obsoletus

Poster Cluster Title: Invasive Spartina Project Updates

Designing High Tide Refuge Islands for the California Ridgway's Rail

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Recovery of the endangered California Ridgway's rail (*Rallus obsoletus obsoletus*) is threatened by a deficiency of high tide refuge habitat, and associated increases in predation, in San Francisco Estuary marshes. This problem will worsen with sea level rise. To decrease predation on the rail, the California Coastal Conservancy constructed 63 earthen, high tide refuge islands over four winters (2013–2016). We strategically located the islands in 13 tidal marshes lacking refuge habitat and designed them to mimic natural slough channel berms dominated by gumplant (*Grindelia sticta*). We annually monitored the islands for 4 years (2013–2016) to evaluate habitat establishment and iteratively modify the design. Our key findings from 2016 monitoring are: (1) gumplant canopy established most rapidly when islands were built with tops approaching the upper limit of gumplant's elevational range; (2) island soil derived from marsh sediments remained horticulturally suitable after construction, but gumplant canopy was enhanced by adding terrestrial soil around plantings, which reduced transplant shock; and (3) islands built to elevations of 1.0 foot and 1.3 feet above mean higher high water (MHHW) (in 2013 and 2014, respectively) provided, on average, about 1 vertical foot of gumplant canopy above the highest predicted tides, the minimal cover needed to hide rails from predation during most extreme high tides. By contrast, islands built to 1.7 feet above MHHW (in 2015 and 2016, respectively) had gumplant canopy on average 3 feet above the highest predicted tides and provided high-quality refuge for rails. On most islands, gumplant established rapidly (within 1–3 years of installation), with gumplant canopy cover averaging 52% across all surveyed islands in 2016. The project demonstrates a feasible and cost-effective method of rapidly providing high tide refuge habitat in tidal marshes.

Keywords: Ridgway's rail, refuge, gumplant, island, climate, rise, endangered, recovery, transition

Poster Cluster Title: Invasive Spartina Project Updates

Enhancing Tidal Marsh Habitat to Support California Ridgway's Rail

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This past winter we implemented the sixth year of the Invasive *Spartina* Project's (ISP) program to rapidly enhance habitat for California Ridgway's rail (*Rallus o. obsoletus*) in tidal marshes affected by the invasion and subsequent removal of non-native *Spartina*. After removal of non-native *Spartina*, natural recruitment of some native species has been very successful (e.g., perennial pickleweed, *Salicornia pacifica*). However, two key components of rail habitat, marsh gumplant (*Grindelia stricta*) and native Pacific cordgrass (*Spartina foliosa*), have not recolonized and/or recruited into some sites, especially young restoration sites that lack local propagule sources. To encourage rapid habitat enhancement focusing on these two species, ISP and partners designed and installed plantings aiming to establish dense, strategically-located patches of vegetation that will benefit nesting, foraging, and roosting rails, as well as provide high tide refuge.

During the past six winters, the ISP and partners have installed more than 400,000 plants, primarily marsh gumplant and Pacific cordgrass, at over 40 sites. Marsh gumplant flowering and seed production, and the presence of new seedlings, has been recorded at ISP sites indicating that the plantings are self-sustaining. Planted cordgrass patches are rapidly expanding laterally at sites where, prior to our planting efforts, native cordgrass was absent. In addition, we have recorded the presence of Pacific cordgrass seedling recruits near our plantings indicating successful seed production and recruitment.

The San Francisco Estuary Invasive *Spartina* Project (ISP), led by the State Coastal Conservancy and the U.S. Fish and Wildlife Service, is a collaboration of many partners around San Francisco Bay to eradicate several species of non-native, invasive cordgrass.

Keywords: Tidal Marsh, California Ridgway's Rail, habitat enhancement, marsh gumplant, cordgrass

Poster Cluster Title: Invasive Spartina Project Updates

McCormack-Williamson Tract Research Project Overview

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With restoration of the McCormack-Williamson Tract (MWT), in the North East Delta, highlighted in multiple management plans for both flood protection and ecosystem benefits, quantifying changes with restoration will benefit future restoration actions throughout the Delta. Integration across fields of study in a large spatial scale is necessary to better understand what processes, both physical and ecological, determine the success of restoration actions. The goal of this project is to collect data prior to restoration in order to obtain baseline information in which to compare to a restored state. We have been collecting water quality, lower trophic food web community, isotopes to describe the isoscape, and constructing a hydrodynamic model to test future hydrodynamic and ecological scenarios. This interdisciplinary approach allows for an integrated dataset where the various disciplines can help to explain findings. On February 11, 2017, MWT levees breached during a winter flooding event and remained connected to the river for 108 days until levees were repaired. This unplanned flooding allowed for a "preview" of a future restored state of MWT. Following the levee breaching, the research team was able to begin sampling within and around the tract for water quality and lower trophic levels. The flooding also allowed for the collection of water stage data that will help to inform the hydrodynamic model. The rare opportunity to preview a large-scale restoration has provided valuable insight and has helped to guide future research questions and monitoring objectives. Additionally, incorporating information from long-term monitoring upstream in the Cosumnes River allows for a better understanding of ecosystem function at the landscape scale.

Keywords: Monitoring, Restoration, Food Web, Isotopes, Hydodynamic Model, Interdisciplinary, Water Quality

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Flooding of McCormack-Williamson Tract Creates High Zooplankton Biomass, a Distinct Zooplankton Community, and Subsidizes Downstream Habitat.

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The restoration of marsh and intertidal habitat in the Delta aims to provide productive high quality habitat to native species. Additionally, restoration actions can influence the productivity of surrounding habitats. In February of 2017, the McCormack-Williamson Tract flooded due to high flows from the upstream Cosumnes River. This unintentional flooding allowed for a four-month experiment to observe food web and zooplankton community structure on the Tract and how outflows influence downstream productivity and zooplankton community assemblage. Sampling occurred weekly on the Tract and monthly in surrounding habitats. The Tract was a highly productive habitat during inundation, supporting a community of high value food resources such as *Daphnia pulex*, a large bodied cladoceran, which made up most of the zooplankton biomass. Additionally, hydrologic conditions increased productivity relative to adjacent habitats. Cluster analysis of Bray-Curtis dissimilarity of the zooplankton community clustered Tract and downstream habitats indicating a high degree of community similarity and that outflows influenced downstream community structure. During inundation, the McCormack-Williamson Tract provided a productive habitat with a unique zooplankton community. Furthermore, it is likely that the Tract's productivity was exported, increasing available food resources to higher trophic levels in downstream habitats.

Keywords: restoration, zooplankton, productivity, subsidy

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

High Frequency Monitoring of Isotopic Signatures in the Flooded McCormack-Williamson Tract Elucidates the Effect of Restoring Floodplain Habitat in the Sacramento-San Joaquin Delta

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Increasing the quality and quantity of habitat for native species in the Sacramento-San Joaquin Delta is a high priority for California water managers. The McCormack-Williamson Tract (MWT) levee failure of February 11, 2017, was embedded within the wettest year of record for the Mokelumne-Cosumnes river system and thus provided a unique opportunity to examine the potential trajectory of future restoration actions within the Delta. We carried out high frequency sampling (n=32, 13% of days) of suspended particulate organic matter (SPOM) and waters in the Mokelumne and Cosumnes river systems, including nearby sloughs, and the post-failure, flooded interior of MWT. Carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes in SPOM and $\delta^{2}H$ and $\delta^{18}O$ of waters were analyzed and *in situ* water quality data were collected in tandem, to contextualize isotopic data. Sampling was confined to an 8 km^2 region surrounding MWT (6.7 km^2 interior). This unintentional flooding provided a natural before-after-control-impact experiment to study the effect that sudden inundation of a Delta island at this elevation can have on food web development and ecosystem function. Source waters were isotopically distinct ($p<.01$), and co-varied along the Global Meteoric Water Line ($R^2>0.99$), providing a semi-conservative tracer of mixing. The $\delta^{13}C$ values of SPOM varied between -37.3 and -23.9‰ and were significantly more negative on the flooded island by 1.2‰, $p<.01$. Potentially due to increased recycling of organic carbon concomitant with accelerated ecosystem metabolism. Concurrently, $\delta^{15}N$ values varied between 1.0 and 12.4‰ and were not significantly different between riverine and flooded island sites. Our data indicate that over short periods of flood inundation (13 weeks) new freshwater habitats exhibit higher productivity than their riverine counterparts and could therefore increase organic matter subsidies to downstream ecosystems. In turn, elevated autochthonous contributions to the food web could support rearing native fish populations by enhancing zooplankton communities.

Student Award Competition: Yes

Keywords: Stable Isotopes, Floodplain, Restoration, Flooding, Levee, Productivity, Fishes, SPOM, Delta

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Hydrodynamic and Water Quality Model of the McCormack-Williamson Tract

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As a part of an interdisciplinary team looking to evaluate the efficacy of an intertidal and floodplain restoration project on the McCormack Williamson Tract (MWT), a hydrodynamic model is being developed. The model is a two-dimensional hydrodynamic model using Deltares Delft3D Flexible Mesh Suite. The model uses an unstructured orthogonal grid and solves both a depth-averaged continuity equation and the full momentum equations. We created the model in order to evaluate the dynamics of the aquatic habitat around the Tract, how proposed restoration alternatives would affect the existing habitat, and to see how various sea level rise and other climate change scenarios would affect the alternatives. We will expand upon the model in order to evaluate water quality as well. With these tools, we can evaluate the transport of nutrients, temperature, and salinity as well as phytoplankton using the Deltares DELWAQ engine, which couples with the hydrodynamic model and ecological data that is being collected.

In order to calibrate the model and provide further insight, we have deployed several pressure transducers in order to gather observed stage data in various locations around the tract and collected water quality data in the study area. During this year's flood season, the Tract's levees were breached which inundated MWT. This opportunity allowed for the deployment of two pressure transducers and a dissolved oxygen meter inside of the flooded tract, as well as extend our water quality monitoring within the flooded Tract. These field data in conjunction with the models will allow us to critically evaluate the long-term hydraulic and ecologic effects of intertidal wetland restoration within the Delta.

Student Award Competition: Yes

Keywords: hydrodynamic modeling, water quality modeling, habitat restoration, McCormack-Williamson Tract

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Hydrospatial Analysis for Evaluating Floodplain Restoration: Application to Sacramento Splittail Habitat on the Lower Cosumnes River, California

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Dynamic interactions between rivers and floodplains drive freshwater ecosystems. In highly modified riverine landscapes, these interactions are reduced and homogenized in space and time. Enhancing river-floodplain connectivity is a common restoration objective, but it is often difficult to determine how various actions, such as levee setbacks or environmental flow releases, will impact physical conditions relevant to ecological functions, such as depth, velocity, duration, timing, and connectivity. Understanding changes to these complex interactions requires improved quantification of spatio-temporal variability of floodplain inundation patterns, or the hydrospatial regime. The research presented here quantifies the hydrospatial regime of a floodplain along the lower Cosumnes River, California, both before and after restoration, and uses this to evaluate changes to Sacramento splittail habitat availability. This approach summarizes physical metrics based on spatially-distributed depth and velocity, derived from 2D hydrodynamic modeling for pre- and post-restoration conditions, at daily time steps for the 100-year-plus flow record of the largely unregulated Cosumnes River. This hydrospatial analysis is then applied to splittail habitat suitability curves, allowing for high-resolution quantification and identification where and when particular floodplain conditions are suitable for life-history needs. This approach is amenable to evaluating changes due to restoration, as changes in mean conditions and variability due to restoration are not consistent across all metrics or floods and may depend on landscape position. For splittail habitat suitability, we found that overall weighted usable area nearly doubles post-restoration; however, there is substantial variability within and across years and across the floodplain. This research refines expectations for restoration, while providing tools to compare relative benefits of flow prescriptions and habitat restoration actions. Hydrospatial analysis quantifies how changes vary over space and time and thus supports management and restoration of floodplains for variable conditions that benefit species, such as splittail, and their ecosystems.

Student Award Competition: Yes

Keywords: flood regime, floodplain restoration, modeling, spatial analysis, habitat, Cosumnes River

Poster Cluster Title: McCormack-Williamson Tract Monitoring and Restoration Preview

Microcystis Blooms and Controlling Factors during Two Successively Severe Drought Years in San Francisco Estuary

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The frequency, intensity and duration of drought and associated cyanobacteria blooms are expected to increase in California with future climate change. As the third (2015) and fourth (2014) most severe drought years on record, the 2014 and 2015 drought years provided an opportunity to determine if successive severe drought years vary in their impact on the structure and function of *Microcystis* blooms in San Francisco Estuary. Field sampling was conducted bi-weekly at 10 stations during the bloom season for a suite of physical, chemical and biological factors. Primary producer biovolume, community composition, toxin production, and growth rate were quantified by chlorophyll *a* concentration, qPCR, microscopy, ELISA assays, and carbon uptake measurements. Inorganic nitrogen sources were determined using stable isotopes. The magnitude of the bloom and associations among physical, chemical and biological variables during the *Microcystis* bloom differed between the two successively severe drought years. Contrary to expectations, *Microcystis* biovolume and chlorophyll *a* concentration were greater in 2014 than 2015, the drier year climatically. Primary producer community composition was also spatially and temporally more variable and contained a greater percentage of total cyanobacteria in 2015 than 2014. Differences between the two years were related to the high frequency spatial and temporal variation in environmental conditions that were more favorable to *Microcystis* during the bloom season in 2014 than 2015, including warmer water temperature, more light in the euphotic zone, increased water residence time and availability of ammonium. Correlation and ordination analysis also confirmed that the two severe drought years demonstrated different functional associations. We concluded that understanding the impact of drought on *Microcystis* blooms requires an evaluation of the impact of high frequency spatial and temporal variation and functional associations of physical, chemical and biological variables for each drought year.

Keywords: *Microcystis,* drought, biovolume, isotope analysis, cyanotoxins, qPCR

Poster Cluster Title: *Microcystis* Blooms in San Francisco Estuary during Drought Conditions: Field and Laboratory Studies Associated with *Microcystis* spp from 2014 to 2016

Spatiotemporal Dynamic Changes in Cyanobacteria Assemblages and Emerging Cyanotoxins in the San Francisco Estuary

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Harmful algal blooms (HABs) are a major environmental concern due to the production of toxins and hypoxic environments. Harmful cyanobacteria can also outcompete nutritious forms of green algae and reduce nontoxic food availability for higher trophic levels. It is therefore crucial to understand the dynamics of the cyanobacterial blooms. In collaboration with the Department of Water Resources and Fish and Wildlife, we have analyzed water samples from ten different sites in the San Francisco Estuary from 2014 to 2016, including the severe drought years. Throughout sampling we discovered a shift in cyanotoxin composition. In 2014 and 2015 microcystins were the only cyanotoxin detected, however in 2016 microcystins were detected less frequently while anatoxin-a and saxitoxin were also detected. In addition, we successfully determined anatoxin synthetase gene from the local algal samples and we are currently measuring abundance of anatoxin producing cyanobacteria using algal samples archived in our laboratory. The spatiotemporal distribution pattern of cyanobacteria will be further discussed in the presentation.

Student Award Competition: Yes

Keywords: Harmful algal blooms, Cyanobacteria, Cyanotoxins, Emerging Contaminants

Poster Cluster Title: *Microcystis* Blooms in San Francisco Estuary during Drought Conditions: Field and Laboratory Studies Associated with *Microcystis* spp. from 2014 to 2016

Biodiversity of Cyanobacteria and Presence of Multiple *Microcystis* Genotypes in the San Francisco Estuary

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Blooms of harmful cyanobacteria can result in water quality deterioration by the production of cyanotoxins. Since the blooms began in 1999, the largest biomass of *Microcystis* was observed during the severe drought in 2014, with median chlorophyll *a* concentration reaching levels that were 13 and 9 times greater than in previous wet and dry years. Apparently, cyanobacteria assemblage seems to be changing. In 2014 and 2015, microcystins were the only cyanotoxin detected, however in 2016, microcystins were detected less frequently while anatoxin-a and saxitoxin were detected. To better understand cyanobacteria assemblages in the San Francisco Estuary, we investigated biodiversity of cyanobacteria by shotgun metagenomic analysis on algal samples collected from 2014 to 2016. Our data indicate that *Microcystis* was the dominant genus found in the SFE from 2014 and 2015 while the relative abundance of other cyanobacteria increased in 2016. Besides *Microcystis*, various cyanobacteria were detected in 2016, including *Anabaena*, *Aphanizomenon*, *Cyanothece*, *Lyngbya*, *Nostoc*, *Planktothrix*, *Pseudanabaena*, and *Synechococcus*. Additional screening also revealed anatoxin and saxitoxin synthetase genes and the presence of multiple *Microcystis* genotypes. These *Microcystis* genotypes may belong to different species within the genus. Interestingly, some of the *Microcystis* genotypes showed high DNA sequence similarity to *Microcystis* detected at other geographical locations such as China. Our qPCR results indicate that the distribution pattern of the two *Microcystis* genotypes found in the SFE was slightly different. We will discuss the ecological niche of the *Microcystis* genotypes.

Keywords: cyanobacteria, *microcystis*, genotypes, cyanotoxin synthetase genes

Poster Cluster Title: *Microcystis* Blooms in San Francisco Estuary during Drought Conditions: Field and Laboratory Studies Associated with *Microcystis* spp. from 2014 to 2016

Establishment of Pure Algal Cultures from the San Francisco Estuary for Testing Differing Water Qualities

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Phytoplankton are the main primary producers in aquatic environments and are critical for productive and healthy ecosystems. Establishment of pure cultures is essential for investigating environmental drivers for algal growth and for testing effects of contaminants (e.g., herbicides), however, only a few pure cultures are currently available, collected from the San Francisco Estuary (SFE). To address the issue, we established a total of 21 phytoplankton cultures, including cyanobacteria (e.g. *Microcystis*, *Anabaena,* etc.), diatoms (*Entomoneis*, *Aulacoseira,* etc.), and green algae (*Volvox*, *Chlamydomonas,* etc.) from algal samples collected in the SFE. Identification of phytoplankton was determined to genus or species level by morphology or genetic sequencing. In addition, we optimized growth test conditions for the cultures, using Erlenmeyer flasks for cluster forming phytoplankton (*Microcystis*, *Anabaena*, *Volvox,* etc.) and 96 well culture plates for single cell phytoplankton (*Thalassiosira*). The growth test using 96 well culture plate is very powerful because the method allows us to test a large number of water samples or various environmental conditions simultaneously and inexpensively (>200 treatments per test). Using the 96 well plate method, we are investigating effects of different salinity levels and nutrient conditions on growth of *Thalassiosira*. Furthermore, using the same method, we are testing suitability of field water for phytoplankton growth, collected from different sites in 2017.

Keywords: Cyanobacteria, water quality, nutrients, phytoplankton, *Microcystis*, Anabaena, herbicides, algae

Poster Cluster Title: *Microcystis* Blooms in San Francisco Estuary during Drought Conditions: Field and Laboratory Studies Associated with *Microcystis* spp. from 2014 to 2016

Detection of Microcystins in Tissue Samples via Gas Chromatography Coupled With MMPB Extraction

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Microcystins, toxins secreted by cyanobacteria, and are hepatotoxic, neurotoxic, and cytotoxic. Upon entry into the liver they covalently bind to protein phosphatase making them difficult to detect with ELISA (enzyme linked immunosorbent assay) or PPIA (protein phosphatase inhibition assay). This results in a drastic underestimation of toxin concentration in samples such as animal tissues and sediments. Detection and quantification of microcystin is crucial when considering bioaccumulation and food safety. We have developed a method of detecting bound microcystins by cleavage of Adda, a unique amino acid found in all microcystins, to yield 2-methyl-3-methoxy-4-phenylbutyric acid (MMPB). MMPB was identified using gas chromatography coupled with mass spectrometry. This method is currently being optimized for detection in tissue and sediment samples. Optimization of this method can allow for accurate detection of microcystins enabling management and policy makers to make effective decisions to improve the health of the estuary. Developments in this technique will be further discussed.

Student Award Competition: Yes

Keywords: Cyanotoxins, Harmful algal blooms, Bioaccumulation, Gas Chromatography, Mass Spectrometry

Poster Cluster Title: *Microcystis* Blooms in San Francisco Estuary during Drought Conditions: Field and Laboratory Studies Associated with *Microcystis* spp. from 2014 to 2016

Nutrients & Dissolved Oxygen in Lower South Bay: Seasonal & Tidal influence

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Lower South Bay margins (sloughs and marshes) receive tidal water from the Bay, urban creeks, and treated effluent from the San Jose-Santa Clara Regional Wastewater Facility. The facility has studied this system for decades and recently increased focus on nutrient concentrations and ecosystem response to nutrient enrichment.

A nutrient concentration gradient from high to low with increasing distance from the RWF was established previously. To characterize responses to high nutrients, we present an analysis of nutrients and dissolved oxygen (DO) data collected monthly at 6 stations near the RWF discharge and continuous DO monitoring at one station in Coyote Creek near Drawbridge. Four continuous DO monitoring deployments were conducted during the year with each deployment spanning 2-weeks to capture spring and neap tides. The deployments coincided with solstices and equinoxes to characterize seasonality during some of the strongest and weakest tides of the year. Because deployments were timed with solstices and equinoxes, staff refer to the project informally as project Stonehenge.

Continuous DO from Project Stonehenge is highly variable with diurnal, tidal, and seasonal effects. Daily oscillations of DO follow a typical diurnal pattern: higher DO in late day, lower DO in early morning. This pattern reflects daily photosynthesis while respiration exerts a constant oxygen demand. Coupling tidal and diurnal changes shows higher DO during late day ebb tides, and lower DO during early morning ebbs. Influence by adjacent marsh water likely accounts for this and the magnitude tracks high and low mixing volumes associated with spring and neap tides.

Seasonal DO concentrations were lower during summer and fall ebb tides compared to flood, indicating higher oxygen demand in shallow marsh with increased temperature and light. Conversely, DO was higher during winter and spring ebb tides, likely due to stable phytoplankton and lower respiration rates.

Keywords: Nutrients, Dissolved Oxygen, Phytoplankton, Nitrogen

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Benthic Invertebrate Composition & Abundance in Lower South San Francisco Bay Margins

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San Jose-Santa Clara Regional Wastewater Facility discharges roughly 80 million gallons per day of tertiary treated wastewater to Artesian Slough and Lower Coyote Creek. To assess aquatic and benthic communities near the RWF discharge area, the facility began a pilot monitoring program in 2016. This program collects baseline information on the aquatic and benthic ecosystem in Alviso Slough, Coyote Creek, and Artesian Slough.

Benthic invertebrate grabs and zooplankton tows were taken bi-monthly at six stations to capture seasonal variability while nutrients and phytoplankton were collected on a monthly to bi-weekly basis at the same stations. This poster represents one of a cluster explaining results from facility Lower South Bay biological monitoring efforts. Results for benthic species community composition and abundance from March 2016 to March 2017 are presented and compared with results from a previous studies in 2014 and 2005.

A total of 45 distinct taxa were identified. The most abundant species included amphipods *Americorophium spinicorne* and *Grandidierella japonica*, clams *Gemma gemma* and *Potamocorbula amurensis*, and annelids *Streblospio benediciti* and oligochaetes. Annelid worms and arthropods were the most abundant groups at all stations while bivalves (clams, mussels and snails) were less abundant throughout the system. Of six stations sampled, the location in Artesian slough had the highest abundance of benthic invertebrates with a mean of over 20,000 individuals per m^2 over the sampling period (7 sampling events). Invertebrate abundance at the Mud Slough station in Coyote Creek was the lowest (14,093 individuals per m^2) and was dominated by *P. amurensis*, *S. benedicti* and oligochaetes.

Keywords: Benthos, benthic, clams, worms, amphipods

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Phytoplankton Community in Lower Coyote Creek a tributary of Lower South San Francisco Bay

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High nutrient concentrations (nitrogen and phosphorus) have contributed to eutrophication in many estuaries. The San Francisco Estuary is nutrient-enriched, particularly in the Lower South Bay (LSB) where the hydraulic residence time is relatively high and receives treated wastewater effluent from the San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF).

To address concerns about potential eutrophication from nutrient enrichment, SJ-SC RWF performed monthly and quarterly monitoring of nutrients in water column at several stations downstream of facility discharge into Artesian Slough and Lower Coyote Creek. In 2016, monthly monitoring of phytoplankton species composition at six stations was added, alternating between spring and neap ebb tides. The objective of this monitoring is to characterize the phytoplankton community in proximity to SJ-SC RWF effluent discharge and look for the presence of Harmful Algal Bloom (HAB) species.

Over the 1-year study period, 105 Genera from 7 divisions were identified. Diatoms made up of the majority of species encountered (87.5%), followed by Cryptophytes (3.5%), Chrysophytes (2.5%), Dinoflagellates (2.3%), Cyanobacteria (2.2%), Chlorophytes (1.9%), and Euglenophytes (0.2%). Presence of HAB species was marginal with one occurrence of the dinoflagellate *Karenia mikimotoi*, at a very low density, and 27 detections of the cyanobacteria Planktothrix.

The Alviso slough station tended to have the highest overall phytoplankton densities, likely due to substantial input from managed pond A8, which has very high densities of phytoplankton. It is important to characterize both phytoplankton overall abundance and community composition because very little is known about specific phytoplankton community variability in South San Francisco Bay and the community response to high nutrient concentrations.

Keywords: Phytoplankton, Diatoms, Eutrophication, HAB

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Fish Populations in Artesian Slough and Lower Coyote Creek

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San Jose-Santa Clara Regional Wastewater Facility collaborated with University of California, Davis, to continue monthly fish population surveys in tidal marsh habitats of Lower South Bay, including Artesian Slough and Lower Coyote Creek. Surveys were performed using 10-minute Otter Trawls at several creek, slough, and Bay stations representing a range of habitats from restored intertidal ponds, subtidal creeks, and outer Bay.

From 2014 to present show presence and seasonal variability of 40+ species of fishes and macro-invertebrates. Species exhibited distributions along the tidal gradient, from predominantly fresh-treated wastewater effluent and creek water to saline Bay water. Surprising year-to-year population variations were documented for some species known to be local slough year-round-residents, such as Three-spined Stickleback, Pacific Staghorn Sculpin and Prickly Sculpin. Fish assemblages varied in response to freshwater supply with higher marine fish abundance and species richness during drought (2014-2015) and more freshwater species during an extreme wet year (2017).

Importantly, tidal marsh functioned as nursery habitat for many species as seasonal presence corresponded to reproductive behavior (e.g. adult Leopard Shark and Bat Ray arrived in spring to give birth), or were “young of year,” arriving as larvae from outside the marsh. Surveys document that restored ponds and adjacent sloughs in Lower South Bay provide spawning and rearing habitat for fishes known to be forage for birds (Northern Anchovies, Pacific Herring, Inland Silversides), recreationally important species (California Halibut, Starry Flounder, Striped Bass) and many native species (Prickly Sculpin, Bay Pipefish and others). Most notably, successful spawning of State-Threatened Longfin Smelt was documented for the first time in March and April 2017 as extreme precipitation and outflows in spring 2017 created a large area of rearing habitat. Results document importance and rewards of CCMP Blueprint Goal #4: “Improve water quality and increase quantity of fresh water available to the estuary.”

Keywords: Fish, Freshwater, Habitat, Restoration, Artesian Slough, Coyote Creek

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Bald Eagle Nesting in Lower South San Francisco Bay

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One highly celebrated outcome of the South Bay Salt Pond Restoration Project in 2017 has been the first documented Bald Eagle nesting and rearing of young in the City of Milpitas in 2017. This event signifies the convergence of at least three long-term trends: chlorinated pesticide bans since the 1970s, Bald Eagle species reintroduction to Central California and recovery since the 1980s, and local habitat restoration in the 2000's. The Milpitas eagle pair is one of seven pairs of bald eagles now nesting in the greater Bay Area. This is an unexpectedly dramatic recovery for a species that was practically extirpated from the United States, apart from Alaska, in the 1970s.

This poster tracks observations from fall 2016, first sighting of the male, through mid-2017, eagle courtship, feeding, nest-building, and rearing and fledging of one chick. The first-ever documented nesting of Bald Eagles in lower Santa Clara Valley was unexpectedly facilitated by nearby salt marsh habitat restoration starting in 2005, and more significant bird habitat management since 2013. Increasing populations of American Coot and wider range of striped bass fishing grounds were specifically observed to be supporting new resident bald eagles as apex predators.

Surprisingly, this pair of eagles chose to nest in a tree in front of an elementary school in a densely populated suburban neighborhood in Milpitas. Adult eagles were not disturbed by throngs of children arriving to school each day and clusters of amateur photographers lingering from morning till sunset. The Bald Eagle pair quickly inspired a dedicated fan club and Facebook group: originally called "Our Milpitas Eagles" now expanded and renamed as "Bay Area Birding and Wildlife." The human response to bald eagle arrival and nesting is as interesting and important to CCMP Blueprint Goal #4 "Champion the Estuary" as arrival of eagles alone.

Keywords: Restoration, Habitat, Bald Eagle, Raptor, Fish

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Pharmaceuticals in Wastewater at San Jose-Santa Clara Regional Wastewater Facility

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San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF) participated in a study of Pharmaceuticals compounds in Wastewater in 2016 that was coordinated by the Regional Monitoring Program for Water Quality in San Francisco Bay (RMP). The SJ-SC RWF is one of the largest advanced wastewater treatment plants in Northern California and discharges to the ecological sensitive Lower South San Francisco Bay.

The facility had previously participated in a 2006 RMP study of pharmaceutical compounds in influent and effluent. In 2009, the facility conducted an environmental fate and transport study of Pharmaceutical compounds in influent, effluent, and solids. These previous studies showed that most quantified pharmaceutical compounds are removed from effluent, however there were a number of compounds (Carbamazepine, Azithromycin, Fluoxetine, Ofloxacin, Albuterol, Lincomycin, Erythromycin) that are not efficiently removed by the advanced treatment process.

As a follow-up to the 2006 and 2009 investigations, the facility collected three rounds of 24-hours composite wastewater samples from four process locations (influent, filter influent, filter effluent and final effluent) and reverse osmosis (RO) reject from Silicon Valley Advanced Water Purification Center (SVAWPC) which is discharged to final effluent. Samples were analyzed for 104 pharmaceutical compounds including antibiotics and antibacterial agents, steroids, analgesics, and other commonly prescribed medications. Out of 104 pharmaceutical compounds analyzed in the first round, 25 were not detected or quantified. The results from this study will be compared to previous studies.

Keywords: Pharmaceuticals, Wastewater Treatment, San Jose

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

Chronic Toxicity Testing at San Jose-Santa Clara Regional Wastewater Facility: a 25-year history

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The San Jose-Santa Clara Regional Wastewater Facility (SJ-SC RWF), the largest wastewater treatment plant in San Francisco Bay, treats wastewater from a customer base of 1.4 million people, or roughly one-fifth of the entire Bay Area population. Roughly 100 million gallons per day of facility freshwater effluent flows through 2-mile long Artesian Slough then into Lower Coyote Creek and out to the Bay. Adjacent to these same waterways, at least 3,000 acres of former salt ponds were opened to circulation from 2005 through 2013.

Posters in this cluster document results from several research projects that document biological response to water quality along roughly 8 linear miles of creek and pond complex to the confluence with Lower South San Francisco Bay. The main

Originally built in 1956 as a primary treatment facility, the wastewater treatment process has been expanded and improved. Since 1998, the SJ-SC RWF has been treating wastewater to tertiary level standards which result in very little BOD and TSS, virtually no ammonia, and low concentrations of nitrogen and phosphorus nutrients on a per capita service basis.

The SJ-SC RWF discharges treated effluent which flows to recently restored wetlands and Lower South San Francisco Bay. This cluster of posters describes environmental science projects to investigate and describe the aquatic ecosystem downstream of the facility. It is hoped that these investigations demonstrate that the facility is supporting all four goals stated in the 2016 CCMP “Estuary Blueprint.”

Keywords: Toxicity, Chronic Toxicity, *Ceriodaphnia*

Poster Cluster Title: San Jose-Santa Clara Regional Wastewater Facility: Sustaining & Improving Water Quality & Habitat of Lower South San Francisco Bay

The Sears Point Experience: Early Returns on a State-Of-The-Art Tidal Wetland Restoration Project

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The Sears Point tidal wetland restoration (SP) story played out over more than ten years and is both unconventional and inspiring. Led by the local Sonoma Land Trust (SLT), the project included acquisition of 2 farms and ranches in historic baylands, funding from dozens of private and public donors, and overcoming design and construction challenges. Ultimately, the San Francisco Estuary (SFE) community celebrated the breaching of the SP dike in October, 2015. End of story? For many, other than permit-required monitoring, yes. However, the SLT had other ideas. As part of the SF Bay Joint Venture, the SLT knew about a movement to establish a regional tidal wetland monitoring program in the SFE. One leader of this movement, the SF Bay National Estuarine Research Reserve (SF Bay NERR), made the case that the SP project could be an excellent project to pilot this concept. While monitoring would satisfy regulatory requirements, additional studies would focus on observations and hypothesis-testing that could lead to adaptive management and generate lessons learned for future tidal wetland restoration projects. The SLT agreed. The SF Bay NERR worked closely with a graduate student studying plantings to stabilize the mounds and test for mound erosion. It worked with a wetland restoration class taught by SFSU Professor Kathy Boyer to measure accretion patterns. Vegetation studies, aerial surveys – including LiDAR, and bathymetric studies have revealed several surprises concerning the biogeomorphic evolution of the site. Special studies on fish use and an innovative citizen science survey of bird use has added additional insights. This poster cluster describes the history of the project, thinking behind its design, challenges of implementation, preliminary observations on post-breach conditions, and how these may lead to future research and management activities on the SP project.

Keywords: Tidal, wetland, restoration, monitoring, citizen, science, adaptive, management, LiDAR, mounds

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Laying the Groundwork for Large-Scale Tidal Wetland Restoration at Sears Point, Sonoma County

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The Sonoma Baylands are a land in transition. The story begins with the Swampland Reclamation Act of 1850 which provided the incentive to reclaim 15,000 acres wetlands for farming to provide hay for the growing town of San Francisco. These farms still retain the signature of historic sloughs and wetlands and allow us to write the next chapter of this story —restoring these diked and drained lands back to marsh. Sonoma Land Trust (SLT) has been actively conserving the Sonoma Baylands since the 1980s. Early work often revolved around opportunistic property acquisitions but gradually led to far larger and more ambitious efforts. The Sears Point Wetland and Watershed Restoration Project began with the threat of casino development and concluded with the acquisition of more than 2,300 acres by SLT and restoration of 1,000 acres of tidal wetlands. Over more than a decade, SLT learned the value and challenges of engaging with the diverse hunting, scientific, agricultural, and tribal interests.

This poster describes and depicts the rich human and ecological history of the Sonoma Baylands and the myriad challenges of setting up and seeing through a project on a landscape scale.

Keywords: restoration, Sears Point, wetland, tidal wetland, acquisition

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Design Considerations of the Sears Point Tidal Marsh Restoration Project

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The 1,000-acre Sears Point Tidal Marsh restoration design combined well-established strategies with several innovative "pilot scale" approaches to address marsh resiliency under sea level rise conditions and within a highly constrained implementation budget. The Sears Point design needs were to (1) reverse historical subsidence to near-MLLW in an era of limited dredged material supply and declining regional (though locally-generated high) sediment loads, (2) protect adjacent diked lands and infrastructure (e.g., Highway 37) from tidal flooding, (3) innovate geotechnical engineering to reuse onsite materials for ecotone levee construction, (4) protect against shoreline erosion, (5) maintain watershed storm runoff to the bay, and (6) integrate with surrounding natural and restored tidal marshlands. A key design objective was to hasten the establishment of vegetated tidal marsh in the site interior, in contrast to the slow process of waiting for accretion to reach suitable vegetation elevations followed by new recruitment and vegetative expansion. The resulting design innovations included vegetated intertidal "marsh mounds" and supratidal sidecast ridges that would serve as interior nuclei for vegetation establishment, break up wind-wave energy to promote sediment deposition, and reduce erosion pressure on the flood protection levee. Numerous small pilot channels, in addition to the large "trunk" channels, aimed to promote formation of a high density, natural channel network. The ecotone flood protection levee includes 10:1 to 20:1 side slopes and several small pannes to reduce erosion, provide estuarine-terrestrial transitional habitats now and with SLR, and provide panne habitat found historically at the marsh-upland edge. This design won the 2005 CCMP Outstanding Implementation Award.

Keywords: tidal marsh, restoration, design, SLR, San Pablo Bay

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Construction Challenges of Translating the Sears Point Restoration Design from Paper to Mud

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San Francisco Bay Estuary is experiencing an unprecedented level of restoration, and more restoration acreage must be completed on a vastly accelerated timeline to achieve agreed upon conservation objectives and to give restoring marshes the opportunity to keep pace. The Sears Point Restoration Project comprises one of several large-scale tidal restoration projects implemented in recent years. Ducks Unlimited carried the preliminary design forward to implementation in partnership with Sonoma Land Trust and US Fish and Wildlife Service. The project design integrated lessons learned from previous smaller-scale projects, including the adjacent Sonoma Baylands, and incorporated a number of specialty habitat features, including root wads, marsh mounds, side cast ridges, miles of channel excavation, marsh pannes, and construction of a large flood control levee with a variable slope designed to provide marsh to upland transition habitat, as well as construction of a large channel linking the primary breach to the Petaluma River Navigation Channel. Earthwork including building a 1 million cubic yard levee – that is a quantity of earth sufficient to fill enough dump trucks to reach from Sears Point to San Diego when lined up end to end. We will share challenges and lessons learned during construction with the hope of informing future implementation efforts. Marsh pannes constructed on the habitat levee did not have a compacted or vegetated edge, and several experienced drainage through low erosive places in the panne rim. Dredging the connector channel in potential endangered species habitat required extensive monitoring and clearance surveys, as well as flexibility to redirect work. Nesting bird avoidance meant clearing much of the site and created a trade-off between giving the construction contractor the capacity to have a longer construction season to reduce overall construction timeline and cost, versus the desire to keep surface roughness.

Keywords: Sears Point, Levee, restoration, accretion, sediment, tidal marsh

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Strategies and Early Outcomes of Revegetating Marsh Mounds at the Sears Point Tidal Wetland Restoration Project

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The Sears Point salt marsh restoration project, located in the San Pablo Bay National Wildlife Refuge, utilizes a novel method of building sediment to accelerate marsh plain development. 500 earthen 'marsh mounds' have been built across the 955-acre site that are intended to lower erosion, promote sedimentation and serve as nuclei for the colonization of marsh vegetation. The levee was breached in October 2015 following construction of the mounds, returning tidal flow to the site. Early monitoring of the marsh mounds indicated that they were rapidly eroding, thus limiting their ability to achieve these goals. This project seeks to determine whether protecting marsh mounds through vegetative plantings and physical protective barriers is an effective method to reduce erosion and potentially promote sediment accretion. Additionally, the study addresses whether active plantings of foundation species can induce more rapid recovery of invertebrate communities. We installed experimental treatments containing plots of native *Spartina foliosa* and coir erosion logs alone and in combination on mounds in the spring of 2016. Plots have been monitored quarterly during the growing season for sediment quality and accretion, infaunal communities and benthic epifauna. Early results show no differences between treatments for sediment quality or accretion in the first year, but a correlation between higher *Spartina* density and lower erosion of mounds. Additionally, benthic epifaunal communities showed a trend towards an immediate response in the first season following planting, with more individuals present on *Spartina* mounds. We discuss the implications of using active revegetation as a strategy for habitat creation in restoration sites, and future planting strategies to maximize ecological recovery at Sears Point.

Student Award Competition: Yes

Keywords: tidal marsh, restoration, *Spartina foliosa*, invertebrate community, sediment, erosion

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Preliminary Findings on Vegetation, Hydrology, and Geomorphic Processes at the Sears Point Tidal Wetland Restoration Project

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The SF Bay National Estuarine Research Reserve (NERR) is conducting a five-year post-breach monitoring and coordinating across other monitoring entities for reporting purposes. The NERR is monitoring vegetation dynamics, geomorphology, and hydrology. A SFSU graduate student is testing techniques for stabilizing and planting the marsh mounds. The Sonoma Land Trust is actively managing invasive plants. Baseline topography by the Corps and mound studies began in 2015, aerial photography and bird studies started in 2016, and fish monitoring, bathymetry, LiDAR, and vegetation studies took place in 2017. Heavy wind events in spring and summer of 2016 and extreme high tides and storms during winter 2017 all exerted tremendous physical forcing on this young restoration site and will influence its long-term restoration trajectory. The unvegetated mounds have sustained erosion of 30-60cm with coarse eroded material deposited nearby. Little natural vegetation recruitment has occurred so far on mounds. However, natural tidal marsh plant recruitment in the intertidal zone of the transition levees has occurred, especially in wind protected areas. Accretion overall has been very high, ranging from 30-80 cm in the northwest over 1.5 years especially in the mound "flow shadows." Natural vegetation recruitment in constructed marsh pannes has been robust. Considerable settling and scour of the levee separating Sears Point from Sonoma Baylands has occurred whereas the northern flood control and habitat levee has held up well. The rapid accretion and mound surface erosion is building a more uniform future marsh plain. Native *Spartina* success on the planted mounds and natural recruitment on the levees has raised Sears Point as a candidate for active ISP *Spartina* revegetation through adaptive management. Sears Point demonstrates that wind flow shadows of mounds and a good supply of suspended sediment can result in rapid marsh plain development despite extreme weather events.

Keywords: Tidal, Wetland, Restoration, Vegetation, Hydrology, Geomorphology, Accretion, LiDAR, Mounds, Pannes

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Documenting Increased Avian Richness and Abundance at the Sears Point Wetland Restoration Project Based on Point County Surveys that Include Citizen Science Monitoring

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To improve the understanding of avian richness and abundance as they forage and nest in restored tidal marsh habitat, eight annual point-count surveys at 12 point-count stations are coordinated by a consulting avian biologist and supported by more than 40 citizen-scientists who have documented the presence of eight avian guilds corresponding to diverse habitat types. Foraging and nesting occurs within diverse habitats such as tidal marsh, tidal mud flat, upland levee, beach, rocky shoreline, open water, and tidal panne. Shorebirds represented 36% of the total observations, followed by diving ducks 17%; dabbling ducks 14%; gulls, 11%; raptors, 11%; grebes 5%; rails 3%; and American Avocet/Black-necked Stilt, 3%. Notable differences in richness and abundance varied by season and shifts in habitat-type among points. Mudflats at low tide yielded greater richness among shorebirds, with Western and Least Sandpiper present at the majority of the 12 points for every survey, along with fewer numbers of Dunlin. Open water habitat at high tide yielded large numbers of diving ducks, with Greater Scaup and Canvasback most commonly recorded, in addition to one stiff-tailed duck guild member: Ruddy Duck. Puddle/dabbling duck guild members documented in the greatest abundance were Gadwall and American Wigeon. Preliminary results suggest that the restoration area provides multiple habitat types for resting and foraging bird species that utilize it within the Pacific Flyway migration corridor and it also serves as valuable stopover/"wayside" habitat. Created habitat at the site includes upland "islands" and emergent vegetation that promises to further increase foraging and nesting success among these species, in addition to potentially attracting listed resident species such as Ridgway's and California Black Rail that occur nearby. Valuable, ongoing citizen science participation for surveys in 2018 will continue to increase managers' insights into design strategies, with results again added to the California Avian Database Center.

Keywords: Avian, citizen science, restoration, point counts

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Fish Habitat Use and Insights from a Paired Sampling Strategy at Sears Point Tidal Wetland Restoration Project

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To improve the understanding of fish habitat use within a newly restored tidal marsh, an Adaptive Resolution Imaging Sonar (ARIS) was paired with traditional sampling gear (i.e., beach seine and otter trawl) to examine the fish community at the Sears Point Wetland Restoration Area (breached in Oct. 2015). Specific objectives of the study included examining fish use of several different habitat types within the restored tidal marsh and identifying the species using the habitats across multiple guilds. During sampling conducted in May 2017, a total of 24 paired transects and 18 paired beach seine hauls were completed. A total of 1,592 fish observations were made with the ARIS (1,018 during trawling and 574 during seining) and 591 individuals were captured with traditional sampling gear (441 by seine and 150 by trawl). Fish sampling resulted in high totals for both observed catch and species diversity (16 species), indicating extensive use of the newly restored habitat by a variety of fish species. Nearly 75 percent of the total fish catch was comprised of native species, with Bay Goby totaling nearly 40 percent of the catch. Differences in relative fish abundance between various habitat types were minimal, potentially due to the proximity and uniformity of many of the sampling sites as well as fluctuating tidal conditions. Notable avoidance behaviors of both beach seines and trawls, particularly among larger fish, were frequently observed after review of the ARIS footage, thus limiting comparisons of the data between the ARIS and each active sampling method. However, utilizing dual sampling methods allowed for a more in-depth examination of the fish fauna in a variety of habitats. More broadly, pairing an ARIS camera with conventional sampling gear that is used extensively throughout the estuary and Delta may yield important information about detection rates of larger, more mobile fishes.

Keywords: Fish Community, Fish Habitat Use, Tidal Marsh Restoration, Paired Sampling,

Poster Cluster Title: Sears Point Tidal Wetland Restoration

Stream Management Master Plan (SMMP): An Updated Regional Vision for Integrated Flood Management

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Zone 7 utilizes planning-level documents to aid in its ability to develop and implement effective stormwater management to reduce flood risks. These plans typically characterize current runoff patterns and areas of flood risk, and propose projects and activities to reduce flooding.

Zone 7 has produced two previous flood management master plans: The 1960 Flood Control Master Plan focused on engineered channels to maximize drainage and convey flood waters out of the Valley quickly during large storm events; and the 2006 Stream Management Master Plan incorporated a more contemporary understanding of watershed processes, how they relate to stormwater runoff and flooding (slow, spread, and sink), and acknowledged the multiple benefits that could be achieved through an interdisciplinary approach to managing storm flows.

Zone 7 began this most recent SMMP update with an eye towards developing a 21st century approach to flood management that: takes into consideration predicted changes in rainfall patterns from climate change models and resilience through adaptation; utilizes a holistic approach to stream management that looks for opportunities to detain flows upstream, use green infrastructure, and enhance the existing ecosystem to provide cost-effective and environmentally sound flood risk reduction alternatives; focuses on developing projects that provide regional benefits beyond flood management while also minimizing project impacts, and, uses up-to-date hydrologic and hydraulic models to identify potential flooding issues and develop regional solutions to reduce flooding.

This update represents the latest efforts to help manage stormwater runoff and reduce regional flood risks to the communities of the Livermore-Amador Valley. The SMMP is a living document and will be updated periodically as new critical information, technologies, and/or specific goals/opportunities are identified. While this Plan does not expressly include water supply needs or projects, Zone 7's regional water management relies on the synergy among stormwater resources, flood channels, and groundwater management.

Keywords: flood management, integrated planning, water agency

Poster Cluster Title: The Face of "Resiliency" -- At the Forefront of Translating Climate Resiliency into Implementation Projects that Reconcile Past, Present, and Future

Preparing for the Storm: Riparian Restoration, Sediment Reuse, and Urban Greening to Enhance Stream and Watershed Resilience

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As San Francisco Bay's watersheds face the twin challenges of urbanization and climate change, comprehensive, coordinated actions are increasingly needed at both the watershed-scale and site scale, immediately along stream corridors. New partnerships will be necessary to systematically improve water quality and aquatic habitat while building the resilience to withstand greater hydrological variability in the future.

Catalyzed by the extensive damage caused by the Winter 2016-2017 floods and the opportunity to align flood response with major habitat improvement, "Preparing for the Storm" is an innovative public-private partnership to improve watershed health and resilience in the Northern Alameda Creek watershed that parallels and complements Zone 7's Stream Management Master Plan Update (SMMP).

Zone 7 will collaborate with a range of organizations, including SFEI, Castlewood Country Club, Concannon Winery, and others, to implement innovative multi-benefit projects on major streamside properties owned by Zone 7 and collaborating landowners. Through Zone 7's SMMP, we will also advance stormwater management in collaboration with local cities, and develop tools for the reuse of coarse sediment both locally and regionally.

There are three major components. Task 1 is devoted to developing science-based plans and tools to guide both the design of immediate implementation projects and dozens of subsequent urban greening and stream restoration projects, through incorporation into city stormwater plans and the Zone 7 SMMP. Task 2 involves design and constructing major aquatic and riparian habitat restoration projects on Arroyo de la Laguna and Arroyo Mocho. Task 3 covers participatory outreach in collaboration with the Living Arroyos watershed stewardship program, involving volunteers in the implementation projects, and through regular interactions with local stakeholders.

Demonstrating a proactive, process-based approach to the large storm events anticipated to be more frequent in coming years, "Preparing for the Storm" provides a regional model for enhancing hydrological and ecosystem resilience.

Keywords: green infrastructure, flood management, restoration, regional planning

Poster Cluster Title: The Face of "Resiliency" -- At the Forefront of Translating Climate Resiliency into Implementation Projects that Reconcile Past, Present, and Future

Arroyo Mocho Stanley Reach: Guiding a Stream Enhancement Project through Drought and Flood — Is this the New Normal?

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The Stanley Reach of Arroyo Mocho, a tributary of Alameda Creek in Alameda County. The nearly mile-long pilot project was intended to explore methods to transform an earthen flood control channel (12.5 acres) into a riparian corridor that will function essentially like a natural stream while maintaining flood control and groundwater recharge functions.

The construction phase ran from summer to fall 2013 and included the removal or modification of four concrete grade-control structures and a concrete velocity dissipater. Two roughened channels were constructed to maintain vertical stability and improve fish passage. Aside from these, no attempt were made to control the course of the Mocho at the site. The stream was allowed to establish its own pattern, profile, and dimension within the existing stream corridor. In addition, over 5,000 riparian trees have been installed at the site including nearly 1,000 willow stakes.

Immediately following construction and initial planting, the region was hit by a severe four-year drought. The drought was brought to a close by an extremely wet winter including several intense storms exceeding a 10-year recurrence interval. The dry conditions severely hindered vegetation growth and establishment, while the storms further exacerbated conditions by eroding banks, scouring out vegetation, and burying portions of the site under several thousand cubic yards of sediment. In 2017, both roughened channels were undermined despite having been designed to withstand much higher flows.

A forensic analysis was conducted on the site geomorphology to understand why the channel responded in this way, and a vegetation analysis has been performed to re-assess the planting strategy. Both analyses were required to take into account that extreme cycles of drought and flood may be the new normal and provide guidance for future projects to ensure that stream enhancement projects can properly respond to climate extremes.

Keywords: Restoration, drought, flood, adaptive management, revegetation, floodplain

Poster Cluster Title: The Face of "Resiliency" -- At the Forefront of Translating Climate Resiliency into Implementation Projects that Reconcile Past, Present, and Future

Arroyo Mocho Medeiros Parkway: Recapturing Historical Function in a Contemporary Landscape

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The 2013 Historical Ecology Study for Alameda Creek assessed overall watershed conditions prior to significant Euro-American modification, including historical patterns of sediment transport and storage in the Livermore Valley. This study served as the basis for integrating historical understanding of watershed functions with current geomorphic research to more effectively inform resource management decisions. A follow up report presented landscape scale management strategies for Arroyo Mocho including process-based approaches for dynamic, multi-benefit urban channels, and identified Arroyo Mocho Medeiros Parkway as a site where some of the contemporary problems could be linked to the historical ecology. The site was also identified as a project in Zone 7's SMMP and is currently in the planning phases.

This multi-benefit project, one of the first SMMP projects Zone 7 is implementing, seeks to reduce flood risk while enhancing riparian habitat and restoring flow to the natural floodplain in the reach of the Arroyo Mocho between Arroyo Road and Holmes Street. Understanding the historical ecology reveals some solutions for regaining some of the function of the site, while additional analysis is needed to understand how the site is functioning in its current contemporary state (e.g., urban setting, altered hydrologic regime, non-native plant communities).

The current conceptual design acknowledges the historical ecology and works with it where possible. However, in many altered urban settings, it is unrealistic to attain full restoration of a historical landscape. Therefore resilient restoration designs should instead be framed around, not just an historical reference but multiple analytical references derived from empirically-calibrated field- and model-based techniques to develop an integrated understanding of contemporary baseline conditions. In this way the Arroyo Mocho Medeiros Parkway project is an example of process-based morphological restoration designed to prompt recovery of ecosystem processes and resilience while meeting management needs of the Zone 7 Water Agency.

Keywords: restoration, detention, flood, historical ecology, sediment, revegetation, floodplain

Poster Cluster Title: The Face of "Resiliency" -- At the Forefront of Translating Climate Resiliency into Implementation Projects that Reconcile Past, Present, and Future

Haunted by the Ghosts of Historical Landscapes: Mapping of 2017 Flood Damage

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The 2013 Historical Ecology Study for Alameda Creek assessed overall watershed conditions prior to significant Euro-American modification, including historical habitat and ecological function in the Livermore Valley. This study served as the basis for integrating historical understanding of watershed functions with current geomorphic research to more effectively inform resource management decisions. The study found that a large marsh complex occupied 2,600 acres across much of now present-day Pleasanton. The marsh was drained starting in the early 1800s and while traces of the "marsh" resurfaced briefly in 1957 during the flood of record, this area of Pleasanton has been largely paved over with development, and multiple channels/canals carry waters through to Arroyo de la Laguna, and eventually out to the Bay through Niles Canyon.

The winter 2016-17 brought an abrupt end to a four-year drought with a thorough drenching of the watershed with some storms exceeding the 10-year recurrence interval in places. Four years of extremely dry conditions for soil and vegetation were followed by high flows that saturated soils, and eroded banks causing extensive bank failures. This was the first year that Zone 7 employed the use of GIS Collector to record and inventory each slide, and keep tabs on photo monitoring and other inspections. Through this data collection effort, mapping revealed a high density of bank failures in the vicinity of the historical marsh complex in Pleasanton.

While knowing the historical ecology helps us understand the root of contemporary issues, given the highly urbanized setting and development to the edge of the channel, it is unfeasible to restore the historical marsh. In lieu of restoring the historical marsh, Zone 7's Stream Management Master Plan is looking to regional detention opportunities to regain some of the ecological functions missing today (e.g., sediment and flood attenuation, wetland habitat).

Keywords: historical ecology, watershed management, flood, bank stability, mapping

Poster Cluster Title: The Face of "Resiliency" -- At the Forefront of Translating Climate Resiliency into Implementation Projects that Reconcile Past, Present, and Future

Phenological Indicators of Wetland Recovery in the Sacramento-San Joaquin Delta

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Plant characteristics have been a key component of restoration monitoring in San Francisco Estuary wetlands. As they show a rapid response to site conditions, fluctuations in plant characteristics can reveal environmental stressors or an unexpected trajectory in ecosystem recovery. Yet the long-term monitoring of plant communities can generate a considerable financial burden for project managers. Remote sensing technology has the potential to expand the spatio-temporal extent of monitoring efforts at low cost, but its use in restoration ecology is still limited. We explored how landscape phenology- which studies variation in the timing of key events in a plant life cycle- can track restoration progress in wetland ecosystems. We analyzed 20 years of free remote sensing data from NASA's Landsat archive to offer a landscape-scale synthesis of wetland restoration efforts in the Sacramento-San Joaquin Delta. Through an analysis of spatio-temporal changes in plant phenology and greenness, we assessed how 25 restored wetlands across the Delta have responded to restoration treatments, time, and landscape context. We used a spline smoothing approach to generate annual phenological curves from Landsat data and identify key phenological events, including timing of peak greenness and growing season length. Preliminary results revealed a greater variability in the initial post-restoration years in both greenness and length of growing season. Sites reached phenological stability on average 4 to 7 years after restoration. More recent sites seemed to benefit from an increased availability of propagules enabling them to reach peak greenness and maximum growing season length more rapidly. These results demonstrate the potential of remote sensing-based phenological analyses to measure restoration progress and compare site trajectories for a better understanding of factors affecting wetland recovery. Phenological time-series can provide useful base data to measure a site's capacity to fulfill ecosystem services including carbon sequestration and habitat provisioning.

Student Award Competition: Yes

Keywords: phenology, remote sensing, wetlands, restoration, Landsat, trajectory

Poster Cluster Title: Variability in Land-Atmosphere Interactions of the SF Bay-Delta's Restored and Natural Wetlands: Implications for Carbon, Methane, and Water Fluxes

Biophysical Controls on Ecosystem-Scale CO2 Exchange in a Brackish Tidal Marsh in Northern California

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Carbon (C) cycling in coastal wetlands is difficult to measure due to dynamic atmospheric and hydrologic fluxes, as well as sensitivities to dynamic land- and ocean-based drivers. Few studies have begun continuous measurements of vertical and/or lateral C exchanges in these systems and as such our understanding of the key drivers of coastal wetland C cycling remains limited. Additional measurements of vertical and lateral C fluxes is critical to developing a better understanding of the drivers of C sequestration and greenhouse gas (GHG) mitigation potential of coastal wetlands. Here we present 2.5 years of eddy covariance measurements of CO_2 and CH_4 fluxes from a tidal marsh in Northern California.

CO_2 fluxes showed large interannual variability, with low net CO_2 uptake in the first year of the study (67 g C m^{-2} yr^{-1}), and much higher uptake the following year (295 g C m^{-2} yr^{-1}). Conversely, annual CH_4 fluxes were similar between years (1.2 and 1.3 g C m^{-2} yr^{-1}). With respect to the net atmospheric GHG budget, the wetland was a net GHG sink of 172 g CO_2eq m^{-2} yr^{-1} in year one, and a sink of 1004 g CO_2eq m^{-2} yr^{-1} in year two. Our results showed that tides strongly influenced CO_2 fluxes across multiple timescales; ecosystem respiration was approximately 25% lower during spring tides relative to neap tides, and flooding overall increased photosynthesis. While several mechanisms can contribute to the suppression of respiration following flooding, our results suggest that tidal effects were largely due to the suppression of CO_2 efflux from the soil as the water creates a physical barrier to gas diffusion, with implications for dissolved inorganic C losses. Further research on lateral C transport is key to investigating the influence of tides on the C balance of coastal wetlands.

Keywords: tidal marsh, carbon sequestration, carbon dioxide, methane, eddy covariance, Suisun

Poster Cluster Title: Spatial and temporal variability in land-atmosphere interactions of the San Francisco Bay-Delta's restored and natural wetlands: implications for carbon, methane, and water fluxes

Evaporation versus Transpiration in Delta Wetlands: The Effect of Wetland Structure on Water Use

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The Sacramento/San Joaquin river delta is an important source of fresh water for California. To reverse soil subsidence, which is linked to draining the natural wetlands for agriculture, parts of the Sacramento/San Joaquin river delta have been restored to managed wetlands. While these restored wetlands provide greenhouse gas benefits compared to agricultural use of the land, implications for the water balance of these ecosystems, specifically evapotranspiration, are not well known.

Based on four years of eddy covariance measurements of water and sensible energy fluxes we explored the water cycling dynamics for six sites under different land use covers, three sites under agricultural use (rice and alfalfa crops and cow pasture) and three restored wetland sites, in the Sacramento/San Joaquin river delta. While the wetland and the rice sites are usually flooded for the majority of the year, the alfalfa, corn, and pasture sites have a water table that is maintained to be below ground level throughout the year. The three wetland sites also have different fractions of open water to vegetation, covering a gradient from very dense vegetation with no open water to a fairly open structure with large pools of open water.

Although the flooded sites tend to have larger annual evapotranspiration than the drained sites, the fraction of open water to vegetation affects the extent to which the flooded sites' evapotranspiration exceeds that of drained sites. Evapotranspiration at the wetland with a low fraction of open water surfaces was almost entirely dominated by plant transpiration with only very little contribution from evaporation. The closed vegetation canopy seemed to be able to inhibit evaporation from subcanopy water. On the other hand, the two wetlands with larger fraction of open water surfaces showed noticeable contribution of evaporation in addition to plant transpiration, increasing the overall water loss through evapotranspiration.

Keywords: Restored wetlands, evapotranspiration, water cycling, structure, water temperature, wetland vegetation,

Poster Cluster Title: Spatial and temporal variability in land-atmosphere interactions of the San Francisco Bay-Delta's restored and natural wetlands: implications for carbon, methane, and water fluxes

Multi-Year Greenhouse Gas Budgets of Restored Wetlands and Drained Peatlands across the Sacramento-San Joaquin Delta, California, USA

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Globally, delta ecosystems are critical for human livelihoods, but are at increasingly greater risk of degradation. The Sacramento-San Joaquin River Delta ('Delta') has been subsiding dramatically, losing more than 100 Tg of carbon since the mid-19th century due in large part to agriculture-induced oxidation of the peat soils through drainage and cultivation. Efforts to re-wet the peat soils through wetland restoration and flooded agricultural crops are attractive as climate mitigation activities and as part of market-based climate policies such as California's Cap-and-Trade program. While flooded wetland systems have the potential to sequester significant amounts of carbon as photosynthesis outpaces aerobic respiration, the highly-reduced conditions can result in significant methane emissions. Due largely to variability in annual photosynthesis and methane emissions, there is high uncertainty in the net greenhouse gas (GHG) budget over the lifetime of a restored wetland.

Initial comparisons in the Delta have shown that conversion of drained peatlands to wetlands can, in some cases, yield a net GHG benefit. Other studies have reported net sources, and turnover times (from a source to a sink) of greater than 500 years. This study will utilize three years (2014-2016) of continuous, gap-filled, CO_2 and CH_4 flux data from a mesonetwork of seven eddy covariance towers in the Delta to compute GHG budgets for the restored wetlands and agricultural baseline sites measured. Sustained global warming potentials will be used to model the source/sink nature of the ecosystem into the future. This work aims to describe the extent to which restored managed wetlands, compared to drained agricultural land uses, can provide a net GHG benefit and contribute to climate change mitigation in a nascent market-based system.

Student Award Competition: Yes

Keywords: greenhouse gas, wetland restoration, eddy covariance, Delta

Poster Cluster Title: Spatial and temporal variability in land-atmosphere interactions of the San Francisco Bay-Delta's restored and natural wetlands: implications for carbon, methane, and water fluxes

Using Remotely Sensed Phenology to Understand Wetland Composition and Dynamics at the Estuary Scale

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Phenological information on seasonal change in wetland vegetation may provide important clues about ecosystem functioning, such as uptake of atmospheric carbon, quality of supported habitats and responses to climatic variability, disturbance and invasions. Such information, however, is difficult to collect in the field in a comprehensive and spatially explicit manner to inform regional-scale wetland management and restoration. Alternatively, time series of high temporal frequency remote sensing data can be used to assess and evaluate landscape-level phenological cycles manifested in seasonal trajectories of spectral reflectance from different plant communities. Our study demonstrates the potential of such remotely sensed phenology to elucidate differences in vegetation characteristics, ecosystem properties and wetland management among a set of natural and restored marshes in San Francisco Bay and west Sacramento-San Joaquin Delta using 2015-2016 satellite data at medium (30m) and high (3-5m) spatial resolution. We use these satellite image time series to construct spatially explicit phenological trajectories and compare their key parameters among different types of wetlands, emergent plant communities and where possible, dominant species, including some of the common invasives. We further consider limitations associated with spatial scale and tidal effects on wetland spectral signatures and discuss the potential of such approaches for cost-effective and repeated monitoring of wetlands in the study region and beyond.

Keywords: remote sensing, phenology, vegetation, carbon, monitoring, dynamics, landscape-scale, marsh

Poster Cluster Title: Spatial and temporal variability in land-atmosphere interactions of the San Francisco Bay-Delta's restored and natural wetlands: implications for carbon, methane, and water fluxes

Ozone Depleting Emissions from a Mesohaline Saltmarsh Heavily Invaded by *Lepidium latifolium*

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Natural emissions of methyl bromide (CH_3Br) and methyl chloride (CH_3Cl) from terrestrial ecosystems might explain the observed missing source of methyl halides to the atmosphere. Both compounds are a major source of halogens into the stratosphere, where Br and Cl act as catalysts in ozone depleting reactions. Real-world measurements of their exchange fluxes are limited and usually involve intrusive techniques. To improve the current understanding of the net budget and to provide a solid foundation for up-scaling purposes, the surface-atmosphere exchange for both methyl halides has been studied during 2016/2017 in a year-long field campaign at Rush Ranch (38.2004 °N, 122.0265 °W), a 4.6 km^2 large brackish saltmarsh in the San Francisco Bay National Estuarine in Suisun Bay (CA, United States), using the non-intrusive micrometeorological Relaxed Eddy Accumulation (REA) technique. With REA measurements, a large area of the salt marsh (multiple acres) can be studied without disturbance.

Concurrently, static flux chamber incubations were conducted over different vegetation species, to identify their relevance in terms of methyl halide emissions.

Our results demonstrate that the saltmarsh ecosystem at Rush Ranch is a substantial source for methyl halides. A rough global extrapolation of these results yields an annual net flux of 52 Gg yr^{-1} for CH_3Cl and 8 Gg yr^{-1} for CH_3Br, respectively, which is close to estimates from chamber based observations from southern California saltmarshes.

Chamber incubations at Rush Ranch revealed that the invasive *Lepidium latifolium* emits a significant amount of methyl halides, less than the native alkali heath (*Frankenia salina*) but much more than the native pickleweed (*Salicornia* spp.) Due to aggressive invasiveness its capability to form dense monospecific patches, *L. latifolium* is the main driver of halide emissions from Rush Ranch. If *L. latifolium.* invasion of *Salicornia*-dominated marshes continues, natural emissions of ozone depleting substances may increase in the future.

Keywords: Methyl halide, flux, micrometeorology, invasion, flux, ozone depletion

Poster Cluster Title: Spatial and temporal variability in land-atmosphere interactions of the San Francisco Bay-Delta's restored and natural wetlands: implications for carbon, methane, and water fluxes

Dismantling the Bay Bridge Old East Span: Controlled Implosion Yields Greatest Net Environmental Benefit for Water and Sediment Quality

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Dismantling of the old east span of the Bay Bridge commenced immediately upon completion of the new east span on Labor Day, 2013. The environmental benefits of removal are reduced hazards to navigation, reduced net fill in the Bay, and removal of pollutant sources contained in the old structure. A significant challenge was how to remove submerged concrete pier foundations with the least environmental impacts. Planning studies showed the greatest net environmental benefit of removal was by means of controlled implosion, rather than conventional mechanical means, which poses greater impacts and risks. Controlled implosion of Pier E3 was successfully implemented as a pilot project in November, 2015.

In addition, the posters in this cluster present the environmental study predictions and findings from three monitored implosion events for water quality and benthic sediment quality. Sound pressure waves impacts were the greatest potential concern and were mitigated by attenuation. Water and sediment quality effects were predicted and proven to be minimal, localized, and temporary. Innovative technologies applied in a setting with a robust environmental baseline demonstrate net environmental benefit.

Keywords: Monitoring, plume mapping, water quality, sediment, implosion, pH, turbidity

Poster Cluster Title: Water Quality and Sediment Monitoring - State of the Art Plume Mapping Technology

Monitoring Water Quality Effects from Controlled Implosion in a Dynamic Tidal Estuary

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Innovative plume mapping technology verified the predictions of minimal, localized, and temporary pH increases following controlled implosion of underwater bridge piers. The transient increase of pH above water quality objectives (8.5) was modeled during environmental planning studies and determined to be the most significant potential water quality impact resulting from controlled implosion, whereas turbidity and dissolved oxygen were predicted to remain within background conditions.

Plume mapping is an innovative technology that has been applied to a variety of stationary discharges, but implosion of underwater structures in a tidal estuary presents a unique challenge. Implosions are timed for slack water, to maximize the performance of blast attenuation systems. Following implosion, affected water masses travel and disperse in response to tide and wind driven currents. The exact location and dispersion of the plume following an implosion is unpredictable because of the dynamic nature of Bay currents.

Current tracking drogues help follow the mass of water affected by the implosion using radio transmitters One vessel trolls back and forth longitudinally through the plume, continuously monitoring pH, turbidity, dissolved oxygen, conductivity, and temperature vs. depth as the sensor array is raised and lowered through the water column.

The maximum pH was as high as 9, and attained the water quality objective (8.5) within an hour. Turbidity effects are indistinguishable from background. Innovative technologies applied to three different implosions under very different tidal and weather conditions show that while effects can vary depending on wind and tide conditions at the time of the event, water quality effects are minimal and transient within a small radius around the imploded structure, as predicted.

Evidence of the implosion and monitoring equipment, graphical data of the monitored parameters and discussion of the results will be presented.

Keywords: Water Quality, monitoring, pH, turbidity, plume, mapping, implosion

Poster Cluster Title: Water Quality and Sediment Monitoring - State of the Art Plume Mapping Technology

Sediment Quality Effects from Bridge Removal

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Investigating impacts to benthic sediment quality in the Bay following pier removal via controlled implosion requires a robust baseline of ambient conditions. Baseline sediment quality has been established by the Regional Monitoring Program in San Francisco Bay (RMP). Sediment quality effects were predicted and verified using pre- and post-implosion RMP techniques: metals concentrations and toxicity testing using sediment-water interface cores (SWIC).

Samples were collected using a Van Veen grab sampler with a random stratified sampling approach. Sediments were subsampled into cores for toxicity testing. The remainder of each grab was homogenized and analyzed for metals. Additionally, sonar surveys of the bottom provided detailed bathymetry of the area before and after the implosion.

Most metals showed no change in concentration post-implosion compared to pre-implosion, with the exception of lead, which were occasionally higher than RMP sediments. This was observed both pre- and post-implosion. Replicate subsamples were heterogeneous, sometimes varying in lead concentrations by a factor of five or more. However, none of the samples, including samples with high lead, showed an increase in toxicity. This suggests that the lead is a result of historic activities, such as sand blasting lead paint from the former east span structure of the Bay Bridge.

Sonar surveys show that pre-existing scour crater around the Piers steadily accumulated sediments after the implosion, showing that the former erosional environment had shifted towards depositional with removal of the pier.

The results show the benefit of establishing a robust baseline in an industrialized urban setting. The RMP data set not only establishes ambient concentrations of lead and other metals, but also shows that toxicity is occasionally observed in SWIC toxicity tests.

This poster presents images of the sonar surveys, photographic evidence of the sediment sampling techniques, description of the data, and the findings.

Keywords: Sediment, RMP, benthic community, sampling, monitoring, metals, toxicity

Poster Cluster Title: Water Quality and Sediment Monitoring - State of the Art Plume Mapping Technology

Expanding Our Outreach, Increasing Our Impact: New Directions in Save The Bay's Community-Based Restoration Program

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Tidal marshes provide critical habitat for wildlife and perform important ecosystem services, such as water filtration, carbon sequestration, and buffering coastal communities from sea level rise. However, only 10% of the bay's original tidal marshes remain in their natural state. Over the past five years, Save The Bay has recruited over 29,000 volunteers to join in the region-wide effort to restore this vital habitat and combat the anticipated impacts of climate change, installing over 93,000 plants and removing approximately 238,000 pounds of non-native weeds from the upland transition zone of tidal marshes. Our community-based approach allows us to educate the public and build a sense of stewardship for bay ecosystems, along with meeting restoration objectives.

In 2016, changes to our educational and corporate partnerships have allowed us to expand our impact even further. We made particularly strong advances in our engagement with low-income communities: of the 2,182 students that attended our education programs in 2016, approximately 60% reside in low-income communities, up from just 20% in 2015. Additionally, the number of students participating in multi-day educational programs increased by 39% to 496 in 2016, substantially increasing the number of students who receive in-depth experiences with habitat restoration and tidal marsh ecosystems.

We also expanded our capacity to facilitate very large restoration events with corporate partners. In June 2016, we hosted 369 summer interns from Facebook at a volunteer event at which approximately 3,360 pounds of non-native weeds were removed in a single day. We have also continued to maintain and grow a 5+ year partnership with Ernst & Young, LLP, hosting over 100 volunteers at our restoration sites every year. These partnerships have allowed us to accelerate progress towards achieving our restoration goals, and also cultivate voices in the community advocating our policy initiatives in support of bay ecosystems.

Keywords: Community-based restoration, environmental education, tidal marsh

Poster Topic Citizen Science

"Otter Spotter": Use of Citizen Science to Document the Recovery of North American River Otters (*Lontra canadensis*) in the San Francisco Bay Area

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Historically extirpated from much of the SF Bay Area, river otter populations are in recovery. Despite ecosystem restoration actions across the Bay Area, resource managers have had little information about current numbers or range. Because they are apex carnivores that directly benefit from restoration and likely affect outcome of recovery actions focused on endangered species, an understanding of their presence/absence is warranted. Presence and "hot spot" areas are also needed by agencies responsible for oil and other spill response. Due to their charisma and dependence upon healthy watersheds, river otters can help achieve awareness and public support for wetland restoration and watershed conservation.

During 2012 the River Otter Ecology Project launched a citizen-science initiative to solicit river otter sightings from the SF Bay region. With the launch of this web-based portal, we initiated outreach and media efforts to train the public on river otter identification and to encourage reporting. We believe multi-pronged outreach, inspires increased appreciation of the importance of healthy watersheds.

We have found that river otters commonly utilize a range of aquatic habitats, including coastal, riverine, lake and pond in all Bay Area counties except San Francisco and San Mateo. It appears that otters are expanding their range to the south through the East Bay, but have not moved into coastal San Francisco, San Mateo or Santa Cruz counties.

As a potential keystone species impacting SF Bay Area aquatic habitats, we strongly prioritize i) a wide-spread baseline population assessment utilizing non-invasive genetic techniques, and ii) an assessment of the role otters play in local aquatic food-webs, particularly given the extent of restoration activities taking place across the SF Bay Area targeting recovery of protected species. We encourage conservation managers to employ otters' popularity in outreach and education to demonstrate the benefits of healthy wetlands and watersheds.

Keywords: citizen science, ecosystem restoration, *Lontra canadensis*, SF Bay, species recovery

Poster Topic Citizen Science

Art Aids Environmental Education at a Shoreline Landfill

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Problem: The public has a relatively low level of knowledge about the dynamic ecosystems of the Bay and of its history.

Approach: “Love the Bulb” uses participatory art to illuminate the past and educate people about local ecosystems. We present art, music, performance, and environmental education events at the uncapped construction debris landfill known as the Albany Bulb. The site has long been home to informal sculpture made from found materials including rebar, driftwood and concrete. By bringing together interdisciplinary scholars and makers from fields ranging from archaeology to studio art to choreography to biology, Love the Bulb is building a community that is educating not just traditional environmentalists, but people in the arts and other disciplines about the history that led to large-scale filling of the Bay and the subsequent emergence of novel ecosystems. We are laying the groundwork for scientist-artist collaborations and citizen science projects that incorporate artistic production.

Through participatory oral history and mapping, we are revealing both the destructive past and the resilience of nature. Through monthly activities that include making art objects out of debris, planting native plants, and observing the dynamic ecosystems at the landfill, our project brings new publics to conversations about habitat protection and public space. Love the Bulb is part of the California Institute for Community, Art and Nature, a project of the Earth Island Institute. It is associated with the UC Berkeley Global Urban Humanities Initiative.

Results: New audiences, including those primarily interested in art, have explored the natural systems at the site. By creating objects such as ephemeral sculptures, participants learn about the dynamism of both natural systems and the human-nature interaction.

Conclusions: At a site challenged by complex management issues, highlighting and valuing a tradition of artistic creation results in greater environmental awareness than erasing the site’s history.

Keywords: arts, education, landfill, resilience, mapping, oral history, culture, parks, management

Poster Topic Citizen Science

Citizen Science at Lake Merritt: Past, Present and Future

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Lake Merritt is a microcosm of the larger San Francisco Bay estuary. Therefore, the efforts of ordinary citizens, guided by the scientific community, to observe and document its inhabitants are bound to yield insights into how the estuary ecosystem functions and responds to increasing environmental changes. Here we review and introduce Citizen Science studies at Lake Merritt, past, present and future.

PAST: The science of marine biological invasions began with Citizen Science. According to Andrew Cohen, "(it) began in the early 1960s, when the staff of the Rotary Nature Center guided Oakland teenager Jim Carlton into a project on the life of Lake Merritt." Mentored by scientists at the California Academy of Sciences in San Francisco, Carlton became a world expert while in high school and established San Francisco Bay as the most invaded estuary in the nation. He returned with Andrew Chang in fall 2016 to see how the community had changed in 50 years.

PRESENT: Today, citizens can contribute to real scientific research using their smartphones. iNaturalist.org is an online community of amateur and professional naturalists that has hosted three citizen science projects focused on Lake Merritt. A recent project, "Lake Merritt Citizen Monitoring Study" is organized with the goal of continuing Carlton's study of Lake Merritt's aquatic community. The extreme rainfall of 2017, created the opportunity to pursue a new line of inquiry -- how the recently well-described community at the Lake recovers from last winter's atmospheric river events.

FUTURE: DNA sequencing has become a great tool for identifying organisms and elucidating lineages between organisms. A "Barcode the Lake" project proposes to use a Citizen Science approach to generate data down to a genetic level on the organisms of Lake Merritt. It will also build transferable STEM skills and field identification skills in participants from the community.

Keywords: Lake Merritt, Citizen Science, iNaturalist, STEM, DNA sequencing, invasive species

Poster Topic Citizen Science

Beyond the Vulnerability Study: Moving from Sea Level Rise Adaptation Planning to Implementation in the San Francisco Bay Area

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Due to the nuanced and local effects of future sea level rise around the San Francisco Bay Area as well as local governments' responsibilities for land use planning and public safety, counties and cities will play critical roles in sea level rise adaptation. However, several hurdles currently prevent Bay Area counties and cities from moving beyond the assessment and planning stage of adaptation. County and city planners lack clear and accessible information on implementing sea level rise adaptation polices. This project attempts to synthesize the current literature and provide local decision-makers with various potential pathways to implementation along with other relevant considerations.

This project exposes local governments to various guiding principles as well as strategy determinants before presenting them with a suite of potential planning, regulatory, market-based, and engineering adaptation tools. The economic, ecological, and social costs and benefits of each tool are compared. Additionally, timeframes, goals, and examples are included for each tool. Legal and scale considerations are also outlined. Lastly, this project includes steps to achieving successful implementation and lessons learned from around the U.S. in order to help San Francisco Bay Area counties and cities become more resilient to the effects of sea level rise.

Student Award Competition: Yes

Keywords: sea level rise, adaptation, counties, cities, climate change, implementation, tools

Poster Topic Climate Adaptation

A New Living Shorelines Project at Giant Marsh: Integration of Restoration Features Across an Elevational Gradient for Sea Level Rise Adaptation

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With concern about climate change-induced sea level rise and increased storm surge, the first living shorelines project in San Francisco Bay was installed in San Rafael in 2012, and evaluated habitat values of native oyster and eelgrass restoration at a scale large enough to also test shoreline protection potential. Building on lessons learned from that first project, the State Coastal Conservancy and project partners are developing a new living shorelines project at Giant Marsh near Point Pinole. This project includes numerous restoration elements from the deep intertidal to the eroding tidal marsh shoreline and up to the estuarine/terrestrial transition zone. Oyster reefs and eelgrass will again be included, as will oyster reefs close to shore in concert with plantings designed to enhance native cordgrass establishment and spread. This shoreline also has habitat appropriate for restoration of the federally-endangered California sea-blite, which will be "arbored" to encourage these shrubs to grow tall to maximize high tide refuge for rare birds and mammals. Plantings at the estuarine/terrestrial transition zone will enhance native plant presence at the site. Monitoring of plants, birds, fish, and invertebrates will permit assessment of habitat values of the various treatments, and physical processes such as wave attenuation, erosion, and accretion will be tracked. The project is currently in the permitting phase, with construction planned for 2018. Project elements incorporate an experimental design that will permit rigorous evaluation of multiple treatments relative to controls and pre-project conditions, thus aiding in the design of future projects to enhance habitat while buffering shorelines against erosion.

Keywords: Living shorelines, eelgrass, oyster, sea-blite, cordgrass, adaptation, sea level rise

Poster Topic Climate Adaptation

Delta Fishes and Multiple Stressors: Native and Non-Native Vulnerability to Elevated Temperature and Salinity

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Drought conditions coupled with climate change are projected to have cascading effects on the California Delta system, including increases in temperature and sea-level rise leading to saltwater intrusion and increased salinity regimes. Little is known about how temperature and salinity stressors interact affecting fish performance. Here, we assessed the capacity of juvenile endangered Delta Smelt (DS, *Hypomesus transpacificus*), invasive Mississippi Silverside (MS, *Menidia beryllina*), and recreationally important Largemouth Bass (LMB, *Micropterus salmoides*) to cope with two co-occurring stressors (temperature *AND* salinity) after an initial single-stressor exposure (temperature *OR* salinity). Critical thermal maxima (CTMax), a measure of upper temperature tolerance, was determined after 0, 2, 4 and 7 days following single and co-occurring stressor exposures. Under control conditions (16ºC, 2.4ppt) CTMax differed among species with MS having the highest CTMax (34.1ºC), DS having the lowest (28.3ºC), and LMB intermediate (32.7ºC). Salinity as a single stressor (12ppt for DS and MS, 8ppt for LMB) had little effect on CTMax, whereas elevated temperature (20ºC) significantly increased CTMax to 35.0ºC (MS), 29.7ºC (DS), and 34.6ºC (LMB). An initial thermal stressor had similar CTMax values in the subsequent co-occurring stressor for DS and MS, whereas LMB showed an additive effect of temperature and salinity such that CTMax further increased to 35.4ºC. An initial salinity exposure rapidly increased CTMax by 1-2ºC in the co-occurring stressor in all species. These data suggest that how salinity influences plasticity in CTMax differs by species, whereas there is a positive relationship between thermal history and CTMax in all species. With increasing frequency and duration of warm Delta water temperatures (summer means of 20-25ºC), it is notable that native DS have upper thermal-tolerance values closest to habitat temperatures (~4-8ºC) compared to non-native species (~10-15ºC). Our hope is that these physiological-health assessments will be useful for future conservation planning for these species.

Student Award Competition: Yes

Keywords: Fish Tolerance, Bay-Delta, Drought, Delta Smelt, Silversides, Largemouth Bass

Poster Topic Climate Adaptation

Transforming the Bay Edge - Strategic Coastal Adaptation Insights from Cost Estimation

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In metropolitan regions made up of multiple independent jurisdictions, such as the San Francisco Bay, adaptation to increased coastal flooding due to sea level rise requires coordinated strategic planning of physical and organizational approaches. Here, we present a flexible method for estimating physical adaptation costs along the San Francisco Bay shoreline. Our goal is to identify uncertainties that can hinder cooperation and decision-making. We categorized shoreline data, estimated the height of exceedance for sea level rise scenarios, and developed a set of unit costs for raising current infrastructure to meet future water levels. Additionally, we explored the potential from a cost perspective for ecological systems to play a role in climate adaptation strategies. Using these cost estimates, we explored critical strategic planning questions including shoreline positions, design heights and infrastructure types. For shoreline position, we found that while the shortest line is in fact the least costly, building the future shoreline at today's transition from saltwater to freshwater vegetation is similar in cost but allows for the added possibility of conserving saltwater wetlands. Regulations requiring a specific infrastructure design height above the water level had a large impact on physical construction costs. Finally, our results show that the costs of raising existing walls may represent 70% to 90% of the total regional costs, suggesting that a shift to earthen terraces and levees will reduce adaptation costs significantly.

Student Award Competition: Yes

Keywords: Sea level rise, coastal flooding, cost estimation, adaptation, levees, seawalls

Poster Topic Climate Adaptation

Lessons from the 2014-2015 Drought

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The 2014-2015 drought tested the bounds of water infrastructure, water management strategies, and ecosystems in the Sacramento-San Joaquin Delta (the Delta) and throughout the state of California. The future will undoubtedly bring more droughts to the region, including more extreme events. Capturing lessons learned is a critical task in preparing to effectively manage water and systems in future droughts in this region, which is central to California's water supply needs and provides habitat for several native, endangered, and migratory species.

A series of interviews were conducted with key managers and stakeholders to better understand drought-response management actions and their effects on the Delta ecosystem, water supply, and agriculture and economy. These interviews provide unique insights on what went right, what went wrong, and how adjustments in management could improve water supply reliability and ecosystem resilience in the next drought. Interview content and background information are synthesized in a concise report for Delta managers and scientists.

The synthesis report provides and overview of drought-related management decisions and summarizes lessons learned. This includes an assessment of how science was used to inform decision-making, how impacts of actions were studied, and take-home messages considered critical by those most closely involved in Delta water management. Key findings and infographics will be incorporated into poster.

Keywords: Drought, Sacramento, San Joaquin, Delta, water, economy, environment, ecosystem, hydrology

Poster Topic Climate Adaptation

Understanding the Broader Consequences of Tidal Wetland Loss for Sea Level Rise Adaptation Planning: San Mateo County Case Study

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Sea level rise vulnerability assessments are increasing in California as a result of state and local government led climate adaptation efforts. Due partly to the proliferation of fine-scale coastal flood models, standardized approaches have emerged for assessing vulnerability of built assets (e.g., roads, buildings, utilities). However, habitat changes and lost ecosystem services are more difficult to quantify because (1) ecosystems are dynamic, requiring more sophisticated modeling of projected temporal changes, and (2) there is no consensus on which services and metrics should be quantified. The disparity makes it challenging for decision-makers to integrate natural and built assets into coastal adaptation planning. Risk to natural systems can be underrepresented, skew prioritization of vulnerable assets toward the built environment, and fail to adequately account for benefits derived from natural ecosystems (e.g., coastal protection, carbon sequestration). Focusing on tidal wetlands in San Mateo County, we are quantifying projected changes in a selection of functions and services that (1) represent a range of ecological and societal benefits, and (2) can best leverage existing data, models, and literature to provide the best available science within the time constraints of decision-making. Ecosystem services include tidal marsh habitat resiliency, population viability of indicator bird species, coarse-level assessment of carbon sequestration capacity, and wave attenuation benefits for coastal defense. Composite maps of projected future changes allow identification of wetlands with high current value that are projected to remain high under a range of future conditions (i.e., resilient) as well as those likely to degrade in the near-term (i.e., vulnerable). In partnership with San Mateo County and the California Coastal Conservancy, the results will be integrated into coastal adaptation and climate action planning processes at the county-level and in the broader San Francisco Bay region, and disseminated as a case study approach more broadly.

Keywords: sea-level rise, tidal marsh, adaptation, accretion, climate change, ecosystem services

Poster Topic Climate Adaptation

Sensitivity of the San Francisco Bay Ecosystem to Future Scenarios

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Ambient nutrient concentrations in San Francisco Bay are high relative to many urbanized estuaries, yet at present the classic symptoms of eutrophication are typically not observed in the Bay. The source of this resistance is hypothesized to be a combination of the light limiting effects of suspended sediments and the presence of benthic grazers, both of which exert strong controls on the phytoplankton population. However, observations in recent years suggest that this resistance may be declining. We present the design of and preliminary results from a study on the range of likely ecological trajectories of the Bay. These trajectories are a result of trends and forecasts of forcing conditions ranging from upwelling and sea surface temperature to stratification and sediment supply. A collection of simplified and complex models are used to investigate these conditions and their effects on eutrophication and other undesirable phenomena, such as harmful algal blooms. The myriad sources of uncertainty and intermittency necessitate a probabilistic, risk-based approach. Understanding how the dynamics of nutrients, hydrodynamics, and biology interact under a rich set of future scenarios will be crucial for mitigation and forward-looking stewardship of the Bay.

Keywords: Nutrients, San Francisco Bay

Poster Topic Climate Adaptation

Testing a Novel Adaptation Strategy in a Coastal Salt Marsh

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Coastal wetlands around the world are threatened by sea-level rise (SLR). While current research demonstrates that many, but not all, wetlands in California are keeping pace with SLR via sediment accretion, this resiliency is expected to only resist SLR projections for 2030 and likely 2050. To ensure wetland resilience for 2100 and beyond, wetland management must incorporate a range of tools at various scales. The Seal Beach National Wildlife Refuge (Refuge) encompasses 911 acres of remnant saltwater marsh in the Anaheim Bay estuary and is a perfect location to test a new SLR adaptation strategy, sediment augmentation, where a thin-layer of sediment is placed on a marsh plain to raise elevations. The Refuge is currently experiencing elevated rates of SLR (~3Xs higher than other California wetlands; 6.23 mm/yr) due to subsidence and with Orange County's imminent plans to dredge the adjacent harbor; this is the perfect opportunity to test sediment augmentation. This project placed 8-10 inches of clean, dredge material on approximately 8-acres of low-elevation (*Spartina*-dominated) marsh. Sediment was transported by floating pipe and placed on the marsh plain using a rainbow sprayer. One year of pre-construction monitoring, started in April 2015, and five years of post-construction monitoring will determine the effectiveness of sediment augmentation at the Refuge. The monitoring program will assess augmentation effects on elevation and sediment dynamics, creek morphology, carbon sequestration including greenhouse gas flux, invertebrates, emergent and submerged vegetation, and avian communities. Preliminary results demonstrate that native cordgrass and picklweed species have begun to colonize along the project site boundary and tidal creeks have begun to reform. The results of this project will be shared via trainings hosted by the USFWS for potential utilization throughout California's salt marsh systems.

Keywords: Salt marsh, wetland, sea level rise, sediment

Poster Topic Climate Adaptation

Effects of Resolution on Multi-Temporal Remote Sensing of Wetlands: Towards a Wetland Vegetation Phenology Indicator

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Wetlands, such as those located in the Sacramento San Joaquin Delta, are currently experiencing ecosystem stress from natural and anthropogenically forced environmental change. It is important to discover new ways to monitor their changes and provide the science necessary to develop informed management procedures and mitigation strategies. Furthermore, observing wetland ecosystems is imperative because they are sentinels of global climate and local hydroclimate variation. Mapping vegetation phenology from remote sensing platforms has been a successful indicator of ecosystem and environmental change in terrestrial environments. A similar metric for wetlands could enable researchers to better understand full impacts of environmental change. Currently, the satellite resolution requirements for such a metric are not well understood as wetland environments are much more spatially complex and temporally dynamic than terrestrial ecosystems, and current earth observing sensors may not be able to adequately capture these variations. This study evaluates the impacts sensor spatial and temporal resolution have on wetland plant functional type (PFT) mapping and phenology profile creation.

Here, detailed PFTs maps were created using 10-m and 30-m satellite images and through classification map comparison it was determined that both resolutions are suitable for mapping PFTs. Phenology profiles for two wetland vegetation community types were created using a 10-m/5-day dataset and were compared to those created using a 30-m/16-day datasets. Temporal resolution tradeoffs were evaluated by comparing phenology profile shapes of different wetland sub-regions in the Delta. This study suggests increased temporal resolution is not always required for monitoring wetland phenology; however, cloud spatial bias is a concern. Phenology profiles differed greatly by wetland type even within the same PFT class, indicating that phenology metrics should be developed separately for different regions in the Delta. These findings provide a useful base for retrospective phenology analysis and important considerations regarding the development of a wetland phenology indicator.

Student Award Competition: Yes

Keywords: Wetland, Phenology, Remote Sensing, Sentinel-2, Landsat 8, Indicator, Resolution

Poster Topic Data and Tools

Applications of UAS (Drones) for Aerial Mapping for Shoreline and Wetland Restoration and Management

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Small unmanned aircraft systems (sUAS; popularly known as “drones”), offer a variety of aerial mapping, imagery, and data collection capabilities with useful applications for shoreline and wetland restoration and management. Low-altitude aerial photogrammetry provides high-resolution digital elevation models, orthorectified images, and topographic contour maps at a fraction of the cost of traditional piloted aircraft surveys and ground-based techniques, allowing for monitoring of shoreline stability, vegetation changes, and impacts from sea-level rise. Key advantages of sUAS compared with other aerial and ground survey methods include reduced costs, allowing acquisition of data in less time with greater spatial and temporal resolution; access to difficult to reach or ecologically sensitive areas; and reduced risks to staff.

We present two recent case studies illustrating the benefits of drone imaging and surveying for wetland restoration, including determination of elevation changes, sediment volumes, slope stability and shoreline erosion under baseline conditions, during and after restoration. The first example is for the Montezuma Wetlands Restoration Project, a 2,400-acre dredged sediment disposal, management, and reuse site located in the Suisun Marsh. The project will allow the placement and reuse of dredged sediments from the San Francisco Estuary to restore approximately 1,450 acres of intertidal marsh, seasonal and managed wetlands, and shorebird habitat, and approximately 425 acres of transitional and upland habitat. The second study is for the Aramburu Island Ecological Enhancement Project in Richardson Bay. Created from dredge spoils and fill in the early 1960s, the 17-acre island became dominated by invasive, non-native plants, with shoreline erosion of up to 6 feet/year. Completed in 2012, the restoration project has the goal of converting unstable and degraded artificial habitat to enhanced terrestrial and intertidal habitat designed to achieve gradual dynamic transition during sea-level rise, and to reduce shoreline erosion using soft engineering conducive to shorebird and seal habitat use.

Keywords: drone, photogrammetry, restoration, habitat, sea level rise, dredge, erosion, monitoring

Poster Topic Data and Tools

Adapting to Rising Tides (ART) Bay Area Sea Level Rise Analysis and Mapping Project: Locally-Refined Maps to Support Sea-Level Rise Adaptation Planning

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In 2011, the Bay Conservation and Development Commission (BCDC) and the National Oceanic and Atmospheric Administration (NOAA) partnered with local, regional, state and federal agencies to conduct an adaptation process in Alameda County. That project, the Adapting to Rising Tides (ART) Alameda County project, developed a number of tools, processes, findings and recommendations applicable to the region. One example is the ART Bay Area SLR Mapping and Analysis tool, which was developed in response to challenges that the ART Alameda County Working Group members and project team had with regional scale sea level rise models. In response, the ART team, working group and AECOM developed maps that identified shoreline type for each 100-foot segment of shoreline, tidal datum for over 900 locations along the shoreline and elevations of the shoreline, leveraging the FEMA San Francisco Bay Area Coastal Study. Other counties expressed interest in the tool and the ART Program partnered with the Metropolitan Transportation Commission to develop similar maps for each county. The ART maps are the most locally refined maps available for adaptation planning and made more so by the intensive local stakeholder review process. The maps include SLR and extreme tide combinations through a unique water levels approach that communicates both temporary and permanent flooding, which provides thresholds for action. The maps also identify low points on the shoreline that lead to inland flooding, allowing limited resources to be directed to the locations that pose the earliest risk to shoreline natural and built communities. This mapping methodology has already supported vulnerability assessments and adaptation planning efforts in four counties and helps support the CCMP Task 15-3: Support local government efforts to develop shoreline vulnerability assessments that include assessment of natural resources as an asset category. Milestone: By 2021, complete vulnerability assessments for all nine Bay Area counties.

Keywords: Sea level rise, adaptation, community and ecosystem resilience

Poster Topic Data and Tools

New Carbon Offset Methodology to Quantify Greenhouse Gas Emissions Reductions from the Restoration of California Deltaic and Coastal Wetlands

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Cultivation of peat soils in the Delta contributes disproportionately to greenhouse gas emissions (GHG) in California relative to agriculture on low-organic matter soils. Since Delta islands were first diked and drained for agriculture in the late 1800s, more than 3.3 billion cubic yards (2.5 billion m^3) of organic soils have disappeared. Islands with elevations as low as 20–25 feet (6–7.5 m) below sea level represent a significant opportunity for carbon sequestration. At the same time, they represent an increasing risk of levee failures that threaten the very farmland and water conveyance systems the levees are built to protect.

A new protocol for restoration of wetlands for the Sacramento-San Joaquin Delta, San Francisco Estuary and in coastal areas of California has been adopted and represents a potential tool for implementing projects that generate offsets for the carbon market and foster increased sustainability. The protocol provides guidance for conversion of traditional agriculture to wetlands and rice cultivation. This conversion reduces GHG emissions by stopping oxidation and increasing storage of soil organic carbon, in addition to other benefits such as stopping or greatly reducing soil subsistence, decreased risks of floods, and improved habitat for migratory birds.

We analyzed three wetlands recently restored on Twitchell and Sherman islands. We quantified GHG emission reduction and financial income associated with the application of the newly adapted protocol. For the 300 to 800 acres (120-320 ha) wetlands, GHG emission reduction ranged from 2 to 9 t CO_2eq $acre^{-1}$ $year^{-1}$ (5-22 t CO_2eq ha^{-1} $year^{-1}$) and 500 to 7,500 t CO_2eq $year^{-1}$ per wetland. The estimated maximum income was \$40 $acre^{-1}$ $year^{-1}$. Results prove converting land from agriculture to wetland can highly reduce GHG emission and create a steady income for land owners, even when wetlands are a weak net GHG source.

Keywords: Carbon, wetlands, protocol, rice, agriculture, GHG emission, GHG mitigation, subsidence

Poster Topic Data and Tools

Modeling San Francisco Bay and Estuary: Climatology and 2014-2016 Warming Conditions

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A three-dimensional numerical modeling system for the San Francisco Bay is presented. The system is based on an unstructured grid numerical model known as Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM). A regional coastal ocean model provides the lateral boundary condition. The SCHISM results from a decadal hindcast run are compared with available tide gauge observations, as well as a collection of observed temperature and salinity profiles.

The observed climatological annual mean salinities at the United States Geological Survey (USGS) stations shows the highest salinities to be in the open ocean and the lowest well north (upstream) of the Central Bay. The corresponding mean SCHISM salinities reproduced the observed variations with location quite well, though with a fresh bias. The corresponding observed mean temperatures within the Bay were 2 to 3^{o} C cooler in the Central Bay than to either the north or south. The surface atmospheric forcing and the heat flux at the western boundary are the two major terms in a SCHISM-based heat budget analysis of the mean seasonal temperature cycle for the Central Bay. In the Central Bay salt budget, freshwater discharged by rivers into upstream portions of the Bay to the north balanced by the influx of salt from the west are the primary drivers of the mean seasonal salinity cycle. The interannual variability in temperatures and salinity will also be examined, in particular the exceptionally warm water temperatures during 2014-2016. Concerning this warming, examination of observations and the SCHISM heat budget during this event suggests that the warming that developed during the second half of 2014 and early 2016 originated in the adjacent California coastal ocean and propagated through the Golden Gate into the Bay, indicating that such warming events may be predictable many months or even several seasons in advance.

Keywords: numerical modeling systems, interannual variability, freshwater discharge

Poster Topic Data and Tools

An Innovative Framework in Assessing Climate Change Impacts on Estuary Inflow

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The health of San Francisco Estuary's ecosystem largely relies on outflow from the Sacramento-San Joaquin Delta which in turn is influenced by the State Water Project (SWP). Climate change induced changes in precipitation, warming, and Sea Level Rise (SLR) will change the amount of streamflow entering the Delta and Estuary, the timing of that streamflow, and the salinity and ocean boundary conditions of the Estuary. The goal of this study is to assess the impacts of those potential changes in precipitation, temperature, and sea level on critical operational metrics including annual SWP deliveries, Lake Oroville storage, and seasonal net Delta outflow. An innovative bottom-up decision scaling approach is adopted for this purpose. The approach identifies possible variation ranges of climatic variables from downscaled Global Circulation Model (GCM) projections. Specifically, the potential range of temperature change is explored by increasing mean temperature in 0.5°C increments from 0°C to 4°C (nine scenarios). Potential change in precipitation is explored from -30% to 30% in 10% increments (seven scenarios). Three SLR conditions are considered, no rise, 15 cm rise, and 45 cm rise. A hydrologic model and a water system model are run sequentially to simulate aforementioned operational metrics under those climate change scenarios. Model results indicate that both SLR and warming would reduce SWP annual deliveries. While SLR shows no clear impact on Lake Oroville storage, warming would lead to declined storage. As expected, increasing (decreasing) precipitation would increase (decrease) SWP annual deliveries and Lake Oroville Storage. Increases (decreases) in precipitation also increase (decrease) seasonal net Delta outflow. However, warming shows nonhomogeneous (across different warming scenarios in different seasons) impacts on net Delta outflow. Compared to warming, SLR exhibits less significant impact on net Delta outflow.

Keywords: Estuary, decision-scaling, climate change, State Water Project, inflow

Poster Topic Data and Tools

Seasonal Variability of Salinity and Stratification Dynamics in Lower South San Francisco Bay

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Lower South San Francisco Bay (SSFB) is characterized by tidal excursions that are comparable to its length, resulting in strong coupling between the central part of the embayment and its perimeter. At a channel station in Lower SSFB, a combination of CTDs and ADCPs were deployed to measure profiles of salinity and velocity from September 2015 through February 2017. This period spanned two winter seasons, but included a relatively dry winter (2015-16) and an exceptionally wet one (2016-17).

In this poster, we will show salinity and hydrodynamic variability comparing a dry period (fall 2015), a weak rainfall winter (January 2016) and a strong rainfall period (February 2017). Comparing these three periods we observe traditional longitudinal strain-induced periodic stratification (SIPS) during the first two periods, but modified by variable lateral circulation. The third period shows strong lateral exchange and counterintuitive salinity variability on the tidal timescale, which we attribute to lateral forcing from perimeter habitats. Together the observations suggest that the tidal influence of the perimeters on an estuarine channel has strong seasonal variability, due to the combined influence of longitudinal and lateral processes.

Student Award Competition: Yes

Keywords: hydrodynamics, seasonal variation, fieldwork, San Francisco Bay, stratification

Poster Topic Data and Tools

A Remote Sensing-Based Model of Tidal Marsh Aboveground Carbon Stocks for Greenhouse Gas Inventories and Climate Mitigation

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Remote sensing based maps of tidal marshes, both of their extents and carbon stocks have the potential to play a key role in conducting greenhouse gas inventories, implementing climate mitigation policies, and aiding coastal climate change adaptation decisions. Our goal was to generate a single remote sensing model of tidal marsh aboveground biomass and carbon that represents nationally diverse tidal marshes within the conterminous United States (CONUS). To meet this objective we developed the first national-scale dataset of aboveground tidal marsh biomass, species composition, and aboveground plant carbon content (%C) from six CONUS regions including San Francisco Bay. The final model, driven by six Landsat vegetation indices and with the soil adjusted vegetation index as the most important (n=409, RMSE=310 g/m^2, 10.3% normalized RMSE) successfully predicted biomass and carbon for a range of plant functional types defined by height, leaf angle and growth form. Model error was reduced by scaling field measured biomass by Landsat fraction green vegetation derived from object-based classification of National Agriculture Imagery Program imagery. We generated 30m scale biomass maps for estuarine and palustrine emergent tidal marshes as indicated by a modified NOAA Coastal Change Analysis Program map for each region. With a mean plant %C of 44.1% (n=1384, 95% C.I.=43.99% - 44.37%) we estimated mean aboveground carbon densities (Mg/ha) and total carbon stocks for each wetland type for each region. San Francisco Bay brackish/saline marshes had the highest C density of all estuarine emergent marshes across the six study regions (2.03 ±0.06 Mg/ha). The overall aboveground biomass carbon density of estuarine emergent tidal marshes in the six regions was 1.78 ±0.05 Mg/ha. This modeling and data synthesis effort will allow for aboveground C stocks in tidal marshes to be included for the first time in the 2018 U.S. EPA Greenhouse Gas Inventory for coastal wetlands.

Keywords: tidal marsh, climate mitigation, greenhouse gas inventory, remote sensing, biomass

Poster Topic Data and Tools

Inundation Patterns in the Delta Ecosystem during the 2016 Wet Season

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Periodic flooding events can give rise to a varied mosaic of aquatic habitats that would otherwise be dry. These episodically-available habitats include river floodplains, which are critical to many native fish species populations in the Central Valley. The Sacramento-San Joaquin Delta is one of the most modified estuaries in the world, with seasonal cycles of floodplain habitat availability fundamentally altered because of reduced inflow (because of dams) and spatial disconnection of floodplains and rivers (because of levees). And yet, during very wet years, some functionality is returned to the river-floodplain ecosystem because of flood bypasses and occasional levee breaks. The objective of this study is to document and characterize the increase in flooded habitat and connectivity during the rising arm and slow drawdown in habitat availability and loss of connectivity during the falling arm of the flood season using the 2016 wet season as an example. We will use monthly cloud-free Landsat data (30m pixel resolution, 7 bands) to track inundated area across the entire Delta. We will examine how changes in habitat availability after flooding vary across Delta regions. Understanding the spatial and temporal heterogeneity of flooded habitat, as well as the type of habitat that becomes available during wet conditions, will point to the potential regional impact of flooding for fisheries populations, as well as key limitations and opportunities for tidal wetland and floodplain restoration in the Delta.

Keywords: wet years, flooding, remote sensing, landsat, floodplain

Poster Topic Data and Tools

Bay Area Advanced Quantitative Precipitation Information Project

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The Advanced Quantitative Precipitation Information (AQPI) project, funded by a $19 million DWR Prop 84 grant, includes C-band and X-band radar units designed to observe low-level atmospheric rivers from the tropics responsible for more than 50% of Bay Area rainfall. Existing S-band radars, designed for Midwest thunderstorms, aim high and miss most ARs. Integrated will be modeling from a variety of federal, state and local agencies. Output will give end users precise information down to a square kilometer with respect to when rain will fall, the expected amount and intensity.

Keywords: water conservation, flood protection, climate change response, sea level rise

Poster Topic Data and Tools

NMFS NOAA/USFWS Biological Opinions and RPAs Data Dashboards and Decision Support

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Real Time Fisheries Decision Support: Accessing more than 48 disparate datasets, the Bay-Delta Live (BDL) decision support and data dashboards for fisheries provide the Delta Operations for Salmonids and Sturgeon and Smelt Working Group technical teams with a platform for visualizing, comparing and analyzing data from surveys and real-time monitoring. The support tools move beyond real time data analysis real-time data to real-time synthesis by providing an interactive and collaborative tool for developing and testing new hypotheses about fishery responses to water operations in the San Francisco Estuary.

Project Highlights: Data aggregation and web service development, data dashboard and visualization development, early warning indicators for fish migration, indices and data calculations, web and mobile access, customized application for random sampling designs, easy access to data for all stakeholders.

What Decisions Must Be Made: Real-time delta hydrologic operations decisions to protect endangered and threatened anadromous fish species. These management decisions for threatened and endangered species must be balanced with water supply and quality regulations in and South of the Delta.

Examples include:

-Use of the Sacramento Trawl, Sacramento Seine, and Knights Landing Catch Indices as indications of out-migrating salmonids to trigger a closure of the Delta Cross Channel Gates (NMFS BiOps Action IV.1.2).

-Monitor the Net Negative flows of Old and Middle River (towards the pumps) to reduce the likelihood of entrainment of fish species of management concern (NMFS BiOps IV.2.3).

Watch upstream environmental conditions (Flow and Water Temperature) as an indication of juvenile fish out-migration into the Delta (NMFS BiOps Action IV.1.1).

Keywords: Fisheries, decision support, operations, salmon, smelt, trawls

Poster Topic Data and Tools

Towards Measured Performance: Habitat Restoration Project Tracking, Assessment and Reporting

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Project Tracker (ptrack.ecoatlas.org) promotes regional capacity to track, assess and report on habitat restoration activities on a common interactive map in EcoAtlas. The development of Project Tracker was initially funded by USEPA and was a collaborative effort between the Sacramento-San Joaquin Delta Conservancy, San Francisco Bay and Central Valley Joint Ventures, U.S. Fish and Wildlife Service, California Departments of Fish and Wildlife and Water Resources, and the San Francisco Estuary Institute. This multi-agency workgroup guided the expansion of EcoAtlas, the State's repository for wetland project data, to include hundreds of additional habitat protection, enhancement, and restoration projects throughout the Central Valley and San Francisco Bay-Delta regions. Detailed qualitative and quantitative project data critical for natural resource managers – such as acres of distinct habitat types, species benefited, funding sources, and project progress towards its performance targets can now be consistently tracked across programs and regions throughout the State.

As new projects develop and existing projects enter new phases, project proponents can easily update associated information by using Project Tracker's online forms. Regional administrators can then, in turn, exercise review authority to ensure consistent data quality according to their own standards. This ability to view projects within the landscape context along with habitat resources, condition assessments, and other project activities provides the information needed for better planning and decision-making. EcoAtlas provides public tools for visualizing and querying project data; analyzing changes in habitat extent and condition; guiding landscape-scale conservation planning; prioritizing habitat restoration projects; evaluating progress towards meeting conservation objectives; building partnerships; and leveraging restoration resources.

By providing the tools needed to track and analyze landscape change and measure success of these efforts, we will improve our ability to report on public investments and conserve important habitats strategically well into the future.

Keywords: project tracking, customized regional reporting, habitat restoration, landscape-scale conservation planning

Poster Topic Data and Tools

Tidal Marsh Restoration Monitoring via Drone Data Analysis: A Case Study

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Monitoring tidal marsh restoration projects is time consuming and difficult. By nature, the conditions in tidal marsh habitats are challenging to work in, and the data collection poses inherent problems. Mapping vegetation establishment in patchy distributions results in various outcomes depending on the methods and individual conducting the work. Microtopographic relief of newly forming sloughs can be difficult to access and accurately measure. Moreover, once the habitats are more well-formed, sensitive species such as salt marsh harvest mouse may be present further complicating monitoring efforts. An emerging solution to all of these problems is using drones and their resulting high-resolution composite aerial photos for data analysis. This poster presents our methods and results on the East Bay Regional Park District's Dotson Family Marsh (Bruener Marsh) as a case study. A 20-minute flight captured several hundred overlapping high-resolution aerial images of the 100-acre study area. The images are then orthomosaically processed into a single, high-resolution, georeferenced composite aerial image and corresponding digital elevation model (DEM) with a vertical resolution of 2-3 centimeters. Remote sensing software can then be used to identify various signatures on the aerial image such as pickleweed plants, mud, and water. Once that data is imported into a GIS, mapping rules can be established to group individual plants into a vegetation community polygon to get accurate and repeatable results for estimating cover. The DEM can be used to identify new tidal slough formation. The extent of the sloughs and their depths can be compared from year to year to understand their change over time. Limited ground truthing is used to error check the results. All of this work can be done at a fraction of the cost of traditional field surveys and will only increase in accuracy and efficiency over time.

Keywords: tidal marsh, drone, pickleweed, monitoring, restoration, Breuner, UAV, gis, Dotson

Poster Topic Data and Tools

A Biogeochemical Modeling Study of San Francisco Bay

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In San Francisco Bay, the ecosystem is largely influenced by the phytoplankton and nutrient dynamics. This study investigates the temporal and spatial variabilities of chlorophyll, NH_4 and NO_3, which will facilitate the ecological management and fishery management in this region. Interannual variabilities will be first analyzed based on the observational data inside the Bay. Then, we will focus on each sub-embayment and study the major drivers for the phytoplankton growth and nutrient variations. To better understand this ecosystem, we will conduct a multi-year modeling study in San Francisco Bay. This model is based on Carbon, Silicate, and Nitrogen Ecosystem (CoSiNE) model and coupled with a Semi-implicit Cross-scale Hydroscience Integrated System Model (SCHISM). It is capable of modeling various water quality parameters in both ocean and estuaries. The model calibration in San Francisco Bay was already done by Liu et al. (2017). The same model setup will be used to investigate long-time ecological changes. The comparisons for chlorophyll and nutrients between model and observation will be presented. In addition, an updated version of CoSiNE model with a better model structure, a separate input file and new functionalities, will be introduced, aimed to facilitate the usage of this model in various water environments

Keywords: Ecosystem, CoSiNE model, phytoplankton, nutrients, biogeochemical modeling

Poster Topic Data and Tools

The Horizontal Levee: Improving Water Quality while Providing Flood Protection and Habitat Improvement

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In response to increased concerns about the effects of wastewater effluent discharges on the San Francisco Bay estuary, innovative approaches are needed that are consistent with other management objectives, such as flood control and habitat restoration. In 2016, the Oro Loma Sanitary District built a horizontal levee test facility to assess the effects of fill material, plant communities and operating conditions on the ability of the system to improve water quality and build organic materials to raise grades. The horizontal levee consists of twelve cells with different fill materials and native plant communities. Nitrified wastewater effluent passes through a surface flow wetland before it flows into a subsurface layer within the levee cells. A loam layer (to support plant growth) overlays sand and gravel subsurface layers that have been amended with organic carbon (i.e. woodchips) to enhance denitrification rates. Monitoring conducted during the first summer following introduction of wastewater into the system indicates that the horizontal levee efficiently removes nitrate and a suite of trace organic compounds (e.g., pharmaceuticals). Despite lowering nitrate concentrations to non-detect levels (<0.1 mg N/l), small but statistically significant ($p<0.05$) increases in dissolved organic nitrogen have also been observed in the subsurface of the horizontal levee and significant removal of phosphorus has not been observed. The ability of the horizontal levee to improve water quality decreased substantially when flow increased to a level that caused water to flow across the ground surface. Future research will focus on system performance during wintertime, when rates of microbial processes are expected to decrease, and the ability of plants to provide organic carbon to support denitrification when the labile organic carbon in the woodchips is exhausted.

Student Award Competition: Yes

Keywords: nitrate, denitrification, subsurface wetlands, trace organic contaminants

Poster Topic Emerging Contaminants

Delta Regional Monitoring Program: Current-use Pesticides and Toxicity Monitoring Results, 2015-16

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The Delta Regional Monitoring Program is a stakeholder-directed project formed to develop water quality data necessary for improving the understanding of Delta water quality issues. One of the initial research focuses is monitoring the occurrence of current-use pesticides and toxicity in Delta source waters. Monitoring began in July 2015 at five sites, representing the major surface water inputs to the Delta. Water samples were collected monthly and during five targeted events (first flush storm event, 2nd significant winter storm, spring runoff, spring irrigation, and summer/fall irrigation). Samples were analyzed for a suite of 154 current-use pesticides in water and 129 current-use pesticides in associated suspended sediment by the USGS Organic Chemistry Research Laboratory. Concurrently collected water samples were tested for toxicity at the UC Davis Aquatic Health Program Laboratory with the application of USEPA chronic assays for *Ceriodaphnia dubia*, *Pimephales promelas*, and *Selenastrum capricornutum*.

During the first 12 months of sampling a total of 54 pesticides were detected in the water and 11 were detected in suspended sediments. All samples contained mixtures of 2 to 29 pesticides and the greatest numbers of pesticides were detected during storm events. Pesticide concentrations ranged from non-detectable to 2630 nanograms/liter, and there were 18 detections above an EPA aquatic life benchmark.

Across all samples, there were 26 instances of toxicity: 13 observed with *C. dubia*, nine with *S. capricornutum*, and four with *P. promelas,* with three instances of fish toxicity diagnosed as pathogen-related. Only a few of the toxicity events coincided with pesticide detections above aquatic life benchmarks and there was no obvious relationship between detections above thresholds and observed reductions in related toxicity endpoints.

As part of a larger ongoing monitoring program these data provide valuable information to scientists and resource managers working to better understand the health of the Sacramento/San Joaquin Delta.

Keywords: Pesticides, toxicity, monitoring,

Poster Topic Emerging Contaminants

Vegetation Development in a Tidal Marsh Restoration Project during a Historic Drought: A Remote Sensing Approach

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Tidal wetland restoration efforts can be challenging to monitor in the field due to unstable local conditions and poor site access. However, understanding how restored systems evolve over time is essential for future management of their ecological benefits, many of which are related to vegetation dynamics. Physical attributes such as elevation and distance to channel play crucial roles in governing vegetation expansion in developing tidal wetlands. However, in Mediterranean ecosystems, drought years, wet years and their resulting influence on salinity levels may also play a crucial role in determining the trajectory of restoration projects, but the influence of weather variability on restoration outcomes is not well understood. Here, we use object-based image analysis (OBIA) and change analysis of high-resolution IKONOS and WorldView-2 satellite imagery to explore whether mean annual rates of change from mudflat to vegetation are lower during drought years with higher salinity (2011-2015) compared to years with lower salinity (2009-2011) at a developing restoration site in California's San Francisco Bay. We found that vegetation increased at a mean rate of 1979 m^2/year during California's historic drought, 10.4 times slower than the rate of 20580 m^2/year between 2009 and 2011 when the state was not in drought. Vegetation was significantly concentrated in areas closer to channel edges, where salinity stress is ameliorated, and the magnitude of the effect increased in the 2015 image. In our image analysis, we found that different distributions of water, mud and algae between years led to different segmentation settings for each set of images, highlighting the need for more robust and reproducible OBIA strategies in complex wetlands. Our results demonstrate that adaptive monitoring efforts in variable climates should take into account the influence of weather on tidal wetland ecosystems, and that high-resolution remote sensing can be an effective means of assessing these dynamics.

Keywords: drought, restoration, South Bay Salt Pond Restoration Project, vegetation

Poster Topic Habitat Restoration

Environmental Factors that Influence Benthic Macroinvertebrate Prey Resources for Waterbirds in Managed Ponds at Eden Landing Ecological Reserve, South San Francisco Bay

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Over 80% of San Francisco Bay's historical wetlands have been lost to habitat conversion, including salt production ponds. Today, the most extensive wetland restoration project on the United States Pacific Coast, the South Bay Salt Pond Restoration Project, has been working to restore these critical habitats to healthy, functional ecosystems for a variety of wildlife. A key objective of this effort is to provide habitat for migratory and resident waterbirds who rely on coastal wetlands for roosting and foraging resources. However, the extent to which management actions can be used to maximize macroinvertebrate prey resources is unclear. This study used multivariate community analyses (RDA and MRT) to evaluate the extent to which environmental factors (i.e., water quality, sediment chemistry, and sediment grain-size characteristics) influence benthic macroinvertebrate community composition in managed ponds at Eden Landing Ecological Reserve in South San Francisco Bay. An emphasis was placed on environmental factors that can be managed through water manipulation (e.g., water depth and salinity). Several environmental factors significantly influenced macroinvertebrate community composition in this study (e.g., pH, salinity, nitrate, sulfur, percent silt, etc.), with salinity and pH explaining the largest proportion of the community variation (~30%). Since salinity is one "manageable" environmental factor, efforts to influence community composition may benefit from modifying pond salinity. In particular, a larger number of taxa occurred at salinities < 44.11 ppt; polychaetes, insects, and copepods dominated salinities ranging from 44.11 ppt to 57.75 ppt; and the only taxa present at salinities exceeding 57.57 ppt were insects and polychaetes. Thus, to maximize taxonomic richness, salinity could be maintained at or below 44.11 ppt, which is near the maximum allowable discharge value. However, for some waterbird species, such as small shorebirds and eared grebes, taxa found in high salinity ponds may provide important foraging resources not found elsewhere.

Keywords: restoration, managed habitats, food webs, multivariate analysis, macroinvertebrate communities, benthos

Poster Topic Habitat Restoration

Reconstructing an Estuarine Beach at Aramburu Island – Shoreline Design Performance Five Years Post-Construction

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The Aramburu Island Shoreline Enhancement Project in Richardson Bay, Marin County serves as a demonstration of a “living shoreline” approach to sea-level rise adaptation. The design was based upon data collected on beach slope, sediment size, and fetch at reference beaches around San Francisco Bay and implemented to inhibit wind-wave erosion of an estuarine shoreline with habitat and recreational uses. Three different beach designs were implemented to reflect different combinations of slope, grain size, and material type. Construction occurred in fall 2011 by grading back the shoreline profile, building low "micro-groins" from small boulders and woody debris to provide partial barriers to longshore drift, and depositing different mixtures of sand, gravel, cobble, and oyster shell hash along the shoreline in ratios based upon estimated incident wave energy. Shoreline geomorphology and bird use were monitored at the site over five years following construction to assess design performance and to understand sediment transport dynamics, resilience of the constructed beach forms, and change in habitat values. The geomorphology monitoring involved qualitative beach condition surveys, shore-normal topographic transect surveys, and drone-based photogrammetry surveys, which present a promising new approach for low-cost, high-resolution terrain mapping and geomorphology change detection at beach restoration sites. In the five years since construction, there has been significant longshore transport of finer-grained beach materials (sand and shell), and concomitant changes in beach morphology. Materials stripped from updrift areas have deposited along spits and behind longshore drift barriers at downdrift locations, creating a changing mosaic of habitats. Despite these changes, the enhancements have provided protection against the high rates of pre-project erosion along most of the shoreline and have provided valuable habitats for shorebirds. Bird use of the enhanced shoreline has increased significantly over pre-project conditions in terms of both abundance and species richness.

Keywords: beach restoration, shoreline geomorphology, soft engineering, living shorelines

Poster Topic Habitat Restoration

The Interagency Development of an EcoRestore Adaptive Management Program

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The California EcoRestore initiative calls for the restoration and enhancement of 30,000 acres of habitat, primarily floodplain and tidal marsh, in the Delta and Suisun Marsh by 2020. As part of this initiative, the Interagency Adaptive Management Integration Team (IAMIT), comprising agency and stakeholder scientists and technical management staff, was charged with developing a white paper describing existing adaptive management resources, how those resources link together, and what resources are currently lacking. The white paper was developed in 2016-2017 and concludes with a series of recommendations for developing a complete, integrated, and financially supported adaptive management program for EcoRestore. We present here the recommendations of the white paper, which integrate existing efforts to enhance coordination, synthesis and evaluation, information sharing, and communication. The desired outcome of implementing these recommendations is a program that 1) supports individual restoration projects, 2) considers local and system-scale effects, 3) sets a stage to evaluate impacts of restoration actions at multiple time and spatial scales, and 4) has an organization structure wherein acquired knowledge is effectively communicated and used for development of subsequent goals, objectives and management actions. While the scope of the program is initially limited to integration of current EcoRestore projects, implementation of the recommendations will provide a strong foundation for a robust, long-term adaptive management program for habitat restoration, based on scientifically rigorous modeling, monitoring, research, and assessment methods.

Keywords: adaptive management, restoration, Delta, coordination, synthesis, evaluation, sharing, communication

Poster Topic Habitat Restoration

Habitat Development on the Napa River: Napa County Flood Protection Project Restoration Progress

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In the Napa Valley of California, a series of over-bank flooding events by the Napa River during the latter half of the 20th century resulted in cumulative economic damage in excess of 500 million dollars. As a result, the Napa County Flood Protection Project (Project) was initiated in 1964 with the U.S. Congress' authorization of a large-scale flood protection project along a six-mile reach of the main stem Napa River and a 1.4-mile reach of Napa Creek within the City of Napa. This flood control and riverine restoration project was jointly designed by the U.S. Army Corps of Engineers (USACE) and Napa County Flood Control and Water Conservation District (District); phased implementation began over 15 years ago and received widespread attention for the innovative "Living River" approach to flood attenuation – achieving 100-year level flood protection by connecting the river to its historical floodplain. Conversion of the Project area from the previously diked agricultural baylands to a mosaic of tidally influenced wetlands required levee removal and breaching, lowering levees, and channel modifications to create flood terraces. Restoration goals included creating and restoring brackish emergent marsh, tidal mudflats, seasonal and emergent wetlands, shaded riverine aquatic habitat, riparian forest and scrub-shrub, high-value oak woodlands, and grasslands. Systematic monitoring is occurring over a 40-year period and was first conducted by USACE before transferring responsibility to the District in 2012. In 2012 and 2017, on behalf of the District, Stillwater Sciences conducted vegetation monitoring studies to document changes in vegetation, soils, and hydrology of the restored area. We present our findings, track progress toward the 40-year goals of the project, and provide information that is useful for guiding adaptive management.

Keywords: restoration, flood control, levee removal, floodplain, wetlands, vegetation monitoring

Poster Topic Habitat Restoration

Benthic Microalgae Primary Production Modeling: A Test Run for the San Francisco Estuary

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Benthic microalgae (BMA) are mud-dwelling photosynthesizers that facilitate many different ecosystem services and influence the benthic-pelagic relationship. These services include such things as provision of oxygen to the benthic microbial community, sediment stabilization, nutrient mitigation, and food web support for both pelagic and benthic zones. However, in the San Francisco Estuary (SFE) the BMA are not frequently studied for how these processes factor into ecosystem functioning. An article by Cloern et al. (2016) highlighted the importance of understanding all primary producing groups and their role in historic estuarine ecosystem functions to plan effective habitat restoration in the SFE.

Presented here are measured rates for a growth season of benthic primary production in First and Second Mallard Branch, Suisun Marsh, CA (data from Louise Lee 2016)- a site that exhibits historic SFE geomorphology with dendritic and dead-end sloughs. The rates are then used to scale primary production rates to an annual production by BMA, and further scaled to habitat extent using an irradiance-based ecophysiological model by Pinckney (1994). Such models as these should be further examined for complete integration into ecosystem restoration planning efforts and refined for the SFE system.

Keywords: Primary Production, Benthic Microalgae, Landscape Scale

Poster Topic Habitat Restoration

Oxygen Dynamics across Scales in Lower South Bay

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The southern-most embayment of San Francisco Bay is nutrient-enriched and strongly tidal. Persistent low primary productivity in the Bay distinguishes it from other enriched estuaries (Chesapeake, Long Island Sound, e.g.), and the driving mechanisms are not fully understood. Lower South Bay (LSB) is surrounded by former salt ponds, most of which have been fully or partially reconnected to the tidal influence of the Bay to facilitate salt marsh restoration. These ponds are transected by tidal sloughs that serve as a conduit between the Bay and the ponds. Continuous observations of oceanographic and water quality parameters, including dissolved oxygen (DO), at seven sites in the Bay and sloughs show that water quality was controlled by a combination of physical and biogeochemical processes. Concentrations of DO in the open Bay were largely driven by tidal advection, where low DO occurred on the lowest, summer tides, suggesting that oxygen was consumed in the margins at the limit of the tidal excursion, and a low-DO water mass was exported to the open Bay on ebb tides. The shallow, quiescent ponds with muted tidal exchange had the highest primary productivity, and in summer months, were a source of chlorophyll and DO-enriched water. Between the tidally-controlled open Bay and the reaction-driven ponds, the sloughs exhibited strong interactions between physical and biogeochemical processes. Here we present the results of two research objectives: (1) to use observations to characterize the mechanisms controlling DO concentrations in the ponds, sloughs, and open Bay, and (2) to separate physical and biogeochemical DO fluxes to estimate respiration at our measurement locations. These analyses inform conceptual and numerical models of hydrodynamic and nutrient-driven processes in LSB, as scientists and managers consider the Bay's current energy balance and how it might change in the future.

Keywords: dissolved oxygen, managed ponds, nutrient-enriched

Poster Topic Habitat Restoration

Preliminary Exploration of Methane Flux from the South Bay Salt Pond Restoration Project

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Coastal wetlands are incredibly valuable environments due, in part, to their ability to sequester and store carbon over long periods of time. There is a growing interest among coastal managers to capitalize on this carbon storage capacity to drive restoration and conservation efforts in the context of emerging carbon markets. The South Bay Salt Pond Restoration Project (SBSPRP) is the largest tidal wetland restoration effort on the West Coast, launched in 2004 with an objective to restore 15,100 acres of industrial salt ponds in the south of the San Francisco Bay back to natural habitat. While wetlands are extremely efficient carbon sinks, they also have the ability to produce and emit greenhouse gasses like methane. Previous studies suggest the production and emission of methane from costal wetland ecosystems may be suppressed by the availability of sulfate in tidally-influenced systems with salinities above 18 ppt. This study used static chambers to measure methane fluxes from salt ponds undergoing various management regimes and an associated, restored marsh in the SBSPRP. Samples were collected in November 2016, January 2017, March 2017, and June 2017, with an additional sampling scheduled for August 2017. Our results suggest that some of the larger salt ponds are releasing measurable amounts of methane throughout year, including systems with salinities above 18 ppt. A better understanding of spatial and temporal variability of methane fluxes from the SBSPRP is necessary to better understand the role that these coastal ecosystems play within global climate change.

Student Award Competition: Yes

Keywords: blue carbon, restoration, methane, South Bay Salt Pond Restoration Project

Poster Topic Habitat Restoration

Expanding the Capacity of Unmanned Aerial System to River Restoration

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The accessibility of unmanned aerial systems (UAS), to both the private and public sectors, affords numerous opportunities to monitor and restore a variety of hydrological processes. Specifically, estuary ecosystems stand to benefit from rapid monitoring campaigns and inexpensive aerial survey techniques. To even further accelerate the use of UAS within the private sector, the Federal Aviation Administration implemented new regulations for commercial UAS in the late summer of 2016, which foster new opportunities for development in a rapidly growing market. Here, we present several examples of how our use of UAS and Structure-from- Motion and multi-special aerial images are used to support river restoration over a range of fluvial environments, extending from estuaries to high-energy gravel-bed systems along the Lower American River and Yuba Rivers in California. We will demonstrate how this technology was deployed to develop high resolution digital elevation models for existing conditions in project design and two-dimensional hydraulic modeling. In addition, we also explore conventional passive optical remote sensing techniques (i.e., multi-spectral aerial images) acquired through UAS platforms, to facilitate bathymetric mapping, image classification, and plant health mapping. UAS technology holds the potential to allow watershed managers a wide range of tools to study, plan, and restore the Estuary's habitats.

Keywords: UAS, UAV, Remote Sensing, Restoration, Multi-Spectral, SfM, Structure-from-Motion, drone, NDVI

Poster Topic Habitat Restoration

Resilient Landscape Restoration on Lower Walnut Creek

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The tidal reaches of Walnut Creek once occupied a wide floodplain that supported a tidal marsh complex along the south shore of Suisun Bay. Mid-century flood control projects confined the creek between engineered levees and disconnected the marshes from the tides. The Contra Costa County Flood Control District is leading the Lower Walnut Creek Restoration Project, which aims to remove or setback the levees and reconnect and restore more than 200 acres of historic floodplain habitat.

The project area includes several former dredge placement sites which are at supratidal elevations and are located adjacent to restorable tidal marsh areas. These sites provide a rare opportunity to restore gently-sloped marsh to upland transition zones. This habitat type is highlighted in the Baylands Goals Project Update (2015) as providing improved ecological value in the near term as well as with future sea-level rise.

The restoration design prioritizes tidal wetland restoration in areas where existing grades are close to tidal elevations, while preserving and enhancing adjacent transition zones to allow for marsh transgression as sea-levels rise. The project will restore and enhance seasonal wetlands to improve the ecological function of transition zones in the near term, and is designed to facilitate the future succession of transition zones to tidal marsh. New tidal channel networks will be integrated with upland drainages, anticipating the extension of tidal channels with rising tides. The project includes landscape management to reduce the concentration of invasive non-native plant species within the transition zones, and will reduce re-vegetation costs through on-site native plant cultivation.

By restoring a full ecotone landscape that includes both tidal wetlands and adjacent transition zones, the Lower Walnut Creek Restoration Project will improve ecosystem function in the near term while creating a tidal marsh complex that will be resilient in the face of rising sea-levels.

Keywords: Tidal Wetland Restoration, Habitat Restoration, Transition Zone, Ecotone, Sea-level Rise

Poster Topic Habitat Restoration - Flood Management/Levees/Dams

The Effects of Wetland Hydraulics on Organic Accretion and Land Subsidence Reversal

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The islands of the Sacramento-San Joaquin Delta have undergone significant subsidence since the native peat marshes were leveed and drained more than 100 years ago. In 1997, studies were initiated to determine whether restoring marshes could reverse land-surface subsidence. Portions of Twitchell Island, a peat island in the Sacramento-San Joaquin Delta, were flooded in order to construct wetland environments. Wetland hydraulics may affect the processes of accretion and subsidence reversal in a constructed wetland environment. This study looks at spatial variation of flow velocity within the West Pond, a constructed wetland on Twitchell Island. The objective is to better understand larger flow patterns within the wetland and assess whether backwater areas, or areas with reduced flow and longer residence times, contribute to increased accretion rates. Velocity measurements were taken at six established piers throughout the wetland. A tracer study was also implemented to identify flow patterns and quantify the residence time distribution. Measured spatial variation of water velocity and flow patterns within the wetland are compared to long-term accretion measurements. Preliminary results indicate that the highest velocities occurred at the location where historical accretion was lowest.

Student Award Competition: Yes

Keywords: Wetland, subsidence, accretion, flow, velocity, tracer, residence time, backwater, delta

Poster Topic Habitat Restoration - Flood Management/Levees/Dams

Restoration Design in the Sacramento-San Joaquin Delta: Lessons from Case Studies

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While the goals for tidal, floodplain, and riparian restoration projects in the Delta may range from meeting habitat mitigation needs to providing benefits such as flood attenuation or water quality improvements, the common goal of restoring self-sustaining native habitats and ecosystems means that most, if not all, restoration projects should be based upon a common set of principles and tools to ensure success. This requires awareness of tidal and riverine processes and disturbance regimes, vegetation, fisheries, and wildlife response to these processes as well as ecological interactions. The ultimate measure of our success will be the degree to which native species are able to use and thrive in the habitats we provide. We build upon experiences throughout the Delta using specific examples to illustrate a variety of methods for restoring ecosystems for a sustainable future. Case studies include projects aimed at enhancing the physical template to restore ecological processes such as restoring tidal action in the Cache Slough region to enhance primary and secondary productivity and food availability for Delta Smelt and other native fishes; increasing tidal access and tidal wetland habitat in the central Delta to support spawning and rearing of salmonids; and combining changes to the physical template with revegetation in the eastern Delta to benefit giant garter snake and native fishes. Another project in the central Delta involves no changes to physical site conditions but is focused on improving vegetation composition and structure to support wildlife diversity, including benefits to Swainson's hawk. For all these projects, the explicit integration of ecosystem processes operating at appropriate scales is a fundamental part of planning, implementation, and adaptive management. Practical but often critical matters of site selection, sequencing, funding, stakeholder interactions, and permitting are also recognized as equally important aspects of restoring or enhancing the Delta for native species.

Keywords: tidal, floodplain, riparian, restoration, ecosystem, sustainable, ecological, salmonids, revegetation

Poster Topic Habitat Restoration - Flood Management/Levees/Dams

The Restoration Gauntlet: Will Your Project Survive?

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The Fish Restoration Program (FRP) will restore 8,000 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh for the benefit of native fish species; however, we must overcome many challenges in order to reach that goal. Restoration projects can face hurdles associated with construction feasibility, funding limitations, constrained timelines, permit requirements, neighboring land uses, or land management, and may require the alteration of ecologically beneficial designs. These challenges and constraints can compromise the effectiveness of restoration projects. While the resulting projects will create suitable habitat, they may not be the ecologically optimal design for the project site.

FRP invites you to discuss our current design alternatives for the Winter Island Tidal Habitat Restoration Project, propose ideas of your own for this project, and discuss with us the various hurdles you would face as a planner implementing your project design.

Winter Island is located near the confluence of the Sacramento and San Joaquin Rivers in the western Delta. As a former duck club, the 589 acre island contains internal channels and wetland habitat, but tidal exchange between the island and surrounding waters is limited to a breach on the eastern levee and two water control structures at the north and south. The project specific objectives of this project will be to (1) enhance rearing habitat for salmonids and Delta Smelt, (2) enhance local productivity, and (3) provide connectivity to the existing wetland habitat. Can you create ecologically beneficial habitat and overcome the challenges of project implementation?

Keywords: Wetland, Restoration, Planning, Design, Outreach

Poster Topic Habitat Restoration - Public Education, Outreach, and Access

California EcoRestore Initiative

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As largest estuary on the west coast, the Sacramento-San Joaquin Delta is both a rich and productive habitat for wildlife, and the hub of California's water distribution system. The Delta a is a highly changed and engineered environment supporting threatened and endangered species, the state's agricultural industry, and water supply for millions. Both the federal and state government have a stake in achieving habitat and ecosystem restoration in the Delta. A key aspect of the Governor's Water Action Plan is aggressive ecosystem restoration to benefit fish and wildlife species recovery. Building on the goals set in California's Water Action Plan, the California EcoRestore initiative will coordinate and advance at least 30,000 acres of critical habitat restoration in the Delta over the next four years. The initiative aims to address the Delta's legacy impacts, as well as effects from the ongoing operation of the state and federal water projects. Driven by world-class science, and guided by adaptive management, this initiative will pursue habitat restoration projects with clearly defined goals, measurable objectives, and financial resources to help ensure success. California EcoRestore's initial goal is to advance Delta habitat restoration associated with existing mandates, pursuant to federal biological opinions, as well as additional habitat enhancements. A broad range of habitat restoration projects will be pursued, including projects to address aquatic, sub-tidal, tidal, riparian, flood plain, and upland ecosystem needs, as well as fish passage improvement in the Yolo Bypass and other key locations.

Keywords: Habitat, Restoration, Conservancy, Ecosystem, Adaptive Management, Native

Poster Topic Habitat Restoration - Public Education, Outreach, and Access

Blue Greenway Re-Vegetation Guide

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The Blue Greenway is a multi-agency vision to create an interconnected system of trails, wildlife habitat, public parks, and open spaces along San Francisco's historically industrialized, in multiple areas, contaminated, southeastern waterfront. Once complete, the Blue Greenway would be 13 miles long, extending from AT&T Park to Candlestick Point, including portions of such sites as Yosemite Slough, Hunter's Point, India Basin, Islais Creek, and Agua Vista Park. The City and County of San Francisco, Department of the Environment, is conducting a Brownfields assessment to support the planning and development of the Blue Greenway with funding support from United States Environmental Protection Agency. As part of this assessment, AECOM, along with stakeholders, developed a re-vegetation guidebook to support the restoration planning of Yosemite Slough and the Blue Greenway. The guide provides re-vegetation guidelines for shoreline habitats, urban parks, and developed corridors focused around the objectives to: 1) Improve Habitat and Habitat Connectivity; 2) Remediate Contaminated Lands; 3) Foster Community Stewardship; 4) Create a Climate Resilient Landscape; 5) Improve Public Access Experience; 6) Protect Water Quality; and 7) Stabilize Shoreline. Included in the guide is a plant list, primarily of native species, that function to meet these objectives. Re-vegetation of the Blue Greenway would reconnect fragmented natural habitats thereby increasing the biological connectivity of the corridor. The guide provides developers with an integrated approach to improving habitat and creating a climate-ready landscape in southeast San Francisco.

Keywords: Re-Vegetation, Climate Resiliency, Shoreline Stability, Habitat Connectivity, Water Quality, Remediation

Poster Topic Habitat Restoration - Public Education, Outreach, and Access

The Novato Creek Dredged Sediment Beneficial Reuse Project: Demonstrating the Technical and Regulatory Feasibility of Local, Opportunistic, Beneficial Reuse

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The beneficial reuse of dredged sediment to nourish wetlands and construct levees is emphasized in the Baylands Ecosystem Habitat Goals Update (BEHGU), SFEI's Flood Control 2.0 Novato Baylands Vision Plan, and the Marin County Flood Control District's Novato Flood Protection and Watershed Program. The 2016 Novato Creek Dredged Sediment Beneficial Reuse Project provided a unique opportunity to couple the flood control and habitat restoration elements of these plans, demonstrate the feasibility of local beneficial reuse, and examine the regulatory framework through which it can be implemented. The Project increased the flow capacity of over 8,000 linear feet of channel through downtown Novato, and used sediments from 2016 and previous dredge rounds to initiate construction of ecotone levees within Deer Island Basin. These levees will be necessary to restore expansive tracts of diked baylands within the basin to tidal action, and protect low-lying areas of Novato (including the Novato Sanitary District wastewater treatment plant) from long-term tidal and watershed flooding. The Project constructed approximately 1,900 linear feet of future levee "core" with close to 7,400 cy of sediment from past dredge rounds, and tested four hydraulic application methods to place about 6,500 cy of 2016 dredged sediments to form the foundation of a future ecotone slope. Hydraulic application facilitated placement of sediment in thin layers, simulating natural depositional processes and minimizing net loss of seasonal wetland habitats. When complete, the levee's gentle side slopes will facilitate ecologically functional estuarine-terrestrial habitat gradients in the short-term, and allow for the sea level rise-driven transgression of tidal marsh habitats over uplands in the long-term. SF Bay Water Board staff worked closely with District staff and partner agencies to develop a project description and permitting strategy for the Project, with the hopes that both will serve as viable, cost-effective models for future beneficial reuse projects.

Keywords: Wetland, restoration, tidal, beneficial, reuse, sediment, permitting, flood, deposition, dredge

Poster Topic Habitat Restoration - Sediment

Beneficial Use of Dredge Material in Wetland Restoration: Progress at the Cullinan Ranch Restoration Project

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Tidal marsh restoration in the San Francisco Estuary often occurs on diked baylands that have subsided several feet below sea level. When breached, they may take decades or, with sea level rise, may never accumulate sufficient sediment to support tidal marsh habitat. In order to accelerate formation of habitat at one such restoration site in San Pablo Bay, the project is incorporating the beneficial use of dredged material. The Cullinan Ranch Restoration Project is a 1,500-acre tidal marsh restoration located on the San Pablo Bay National Wildlife Refuge (Refuge). In January 2015, 1,210 acres of the site was breached to the tides. The remaining 290 acres are being managed by the Refuge and Ducks Unlimited (DU) for beneficial use of dredge material. The goal is to expedite tidal marsh habitat by increasing ground elevation 6 feet through the import of 3 million cubic yards of dredged sediment.

To date, the project has imported 370,000 cubic yards of sediment. The material has been imported and placed using different techniques: truck, mechanically by barge, and hydraulically by barge. Import by truck proved effective for small quantities moved over short distances. While this method allowed for exact placement within the project site, the site location made it impractical at a large scale. Mechanical placement from a barge was more efficient in importing large quantities of sediment, but it was spatially restricted and necessitated the relocation of the material, which proved difficult and costly. Hydraulic placement has proven to be the most scalable, although this method requires the most specialized equipment, extensive site preparations, and substantial onsite water management. In 2017, DU expects to hydraulically import an additional 350,000 cubic yards of dredge sediment. Project success requires well-coordinated planning and partnership with dredgers, regulatory agencies, and conservation entities throughout the San Francisco Estuary.

Keywords: restoration, marsh, wetland, habitat, sediment, subsidence

Poster Topic Habitat Restoration - Sediment

Accelerated Growth of Juvenile Salmon in a Managed Pond Relative to Historic and Leveed Sloughs in Suisun Marsh

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Changes to Suisun Marsh, in the San Francisco Estuary, have led to the decline of many native fishes. Levees, duck clubs, and development have confined channel networks and reduced tidal marsh habitat valuable to juvenile fishes. To understand how this altered ecosystem supports native fish, juvenile Chinook salmon (*Oncorhynchus tshawytscha*) were reared in cages for seven weeks in three discrete habitat types: a slough surrounded by historic marsh, a leveed slough adjacent to managed wetlands, and in a duck club pond. Zooplankton, macroinvertebrate, and water quality samples were collected throughout the study period, while fish were measured and weighed every two weeks. Growth rates across time differed significantly between the slough sites and the duck club. Both slough sites saw low or negative growth rates (-0.4 – 1.0 mg/day), whereas fish reared in the duck club pond displayed positive growth (7.7 mg/day). Fish in the leveed slough showed increased growth during adjacent managed wetland draining cycles, but low growth when draining was discontinued. Fish in the historic marsh site displayed low or negative growth throughout the project, likely due to a lack of food resources. The duck club had the greatest abundance of food and provided more consistent and cooler temperatures over the course of the study, which may have offset low dissolved oxygen levels. Additionally, water in the pond was less turbid in comparison to slough sites, which may have enhanced visual foraging success of the salmon. Overall, food accessibility and cooler, stable temperatures allowed fish in the duck club to grow significantly faster than their slough counterparts, highlighting the potential of managed ponds and wetlands as valuable rearing habitats and productive food export systems for juvenile native fishes.

Student Award Competition: Yes

Keywords: salmon, native fishes, managed wetlands, habitat, cages, experimental ecology

Poster Topic Habitat Restoration - Species and Communities

An Assessment of Process-Based Concepts for Channel-Floodplain Reconnection in the Sacramento-San Joaquin Delta

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Historically, native salmonids and other fish spawned and reared in the freshwater marshes that filled the Sacramento-San Joaquin Delta and the floodplains of the channels entering the Delta. Over the past 200 years, widespread diking for land reclamation and flood control has resulted in considerable channel-floodplain disconnection and a dramatic decrease in rearing habitat, in addition to other impacts to native wildlife that historically used the Delta floodplains. This project focuses on using outputs from several recent Delta ecosystem science efforts to identify process-based restoration concepts for reconnecting Delta channels to adjacent floodplains. The project operates at two scales: 1) Delta-wide, encompassing the fluvial, fluvial-tidal, and tidal zones; and 2) local scale, focusing on areas along a corridor through the Delta containing public lands (the Central Delta Corridor) that spans all three zones. During an initial Delta-wide analysis, channel-floodplain reconnection concepts that are appropriate for each zone will be identified. Next, zone-appropriate channel-floodplain reconnection concepts for potential restoration areas along the Central Delta Corridor will be identified, focusing on habitat needs for native salmonids. This presentation will provide an overview of the change in channel-floodplain connectivity throughout the Delta, the extent of the three Delta zones, and a preliminary description of process-based restoration concepts aimed at channel-floodplain reconnection that are appropriate for each Delta zone.

Keywords: Delta restoration, channel-floodplain reconnection, salmonid habitat, multi-benefit management

Poster Topic Habitat Restoration - Species and Communities

South Bay Salt Pond Restoration Project Phase 2: Balancing Habitat Restoration with Public Access and Flood Risk Management in Construction Designs

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Phase 2 of the South Bay Salt Pond Restoration Project proposes to restore approximately 2,200 acres of former salt production ponds into tidal marsh habitat and managed ponds at the Don Edwards San Francisco Bay National Wildlife Refuge (Refuge). The project's goals are to restore and enhance wetland habitats, provide public access and recreation, and maintain existing flood risk management in the South San Francisco Bay. The Phase 2 construction design incorporates these guiding goals and lessons learned from previous phases' construction and ongoing research conducted by the Refuge. Phase 2 proposes to gradually restore and enhance ponds and tidal wetlands with the construction of levee modifications, habitat islands, upland transition zones, ditch blocks, and water control structures. Use of upland transition zones and beneficial re-use of upland fill to create them are new features for the Refuge that was not used in the Phase 1 actions.

At select locations levees would be breached, enhanced, lowered or removed. These activities involve raising, widening, compacting, and otherwise improving existing levees wherever necessary, as well as increasing habitat connectivity and native plant composition. Within specific ponds, habitat islands or upland transition zones would be constructed from imported fill and existing levees to increase the quality, complexity, and availability of bird habitat in the Refuge. At four locations within the Ravenswood Ponds, water control structures would be installed to better manage water levels and water quality in the ponds. Ditch blocks would be placed within existing borrow ditches to enhance natural channel development. The Phase 2 plans also incorporate public access features that balance public engagement with wildlife sensitivities.

All of these project features resulted from a compilation of knowledge from engineers, environmental scientists, stakeholders, biologists, the public, and the ongoing research conducted by the Refuge and its partners.

Keywords: habitat restoration, south bay salt pond, tidal, wetlands, marsh, wildlife

Poster Topic Habitat Restoration - Species and Communities

Avian Response to Restoration of North Bay Salt Ponds: Managed vs. Breached Ponds

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San Francisco Bay (SFB) is important habitat for migrating and wintering waterbirds, and much as 15% of SFB wintering waterfowl are found in North Bay salt ponds. The Napa-Sonoma Marshes Wildlife Area and surrounding areas comprise over 5100 ha of wildlife habitat, and thus are the focus of intense multi-agency efforts to achieve restoration and wildlife management goals. Since tidal flow has been restored to 61% of the pond area, the challenge central to the restoration is to balance needs of marsh species with needs of migratory waterbird populations as breached ponds transition to tidal marsh. We examined the waterbird response to restoration efforts and compared use of managed ponds to breached ponds. We collected water quality data and conducted spatially-explicit high tide (HT), counts of all waterbirds in 14 ponds monthly from Dec 2002 – May 2017. Across all ponds, waterbird abundance has increased since surveys began. Dabbling ducks were most abundant in the fall on larger, lower salinity ponds, but there was no difference between managed and breached ponds. Diving ducks were associated with larger, lower salinity managed ponds, and were most abundant in winter. Small and medium shorebirds were both most abundant on lower salinity managed ponds in the fall. In summary, restoration efforts appear to have been successful at providing HT habitat for increased abundances of waterbirds. In particular, managed ponds are important HT habitat for diving ducks and shorebirds. However, as breached areas transition to tidal marsh, loss of shallow roosting and foraging habitats may result in increased pressure on managed pond habitat resources, and present challenges for managers attempting to maintain migratory waterbird populations. Examination of waterbird abundances and behavior in breached and managed ponds at low tide would help managers better understand the importance of these varied habitats throughout the tidal cycle.

Keywords: salt ponds, north bay, waterfowl, shorebirds

Poster Topic Habitat Restoration - Species and Communities

High- and Low-Tide Waterbird Use of the Cullinan Ranch Restoration Area

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Cullinan Ranch, a former tidal wetland in Napa-Sonoma Marsh, was diked in the 1880's for farming. In 2015, tidal flow was restored to 1200-acres of this site. Given that this site has subsided nearly two-meters below mean sea level, sedimentation and transition to tidal marsh are expected to take up to 60-years; however, the reintroduction of tidal flow created potentially valuable interim open-water habitat for waterbirds. To assess response to initial restoration efforts at Cullinan ranch, we conducted post breach high and low tide waterbird surveys in fall 2017, and winter and spring 2016 – 2017. We observed a total of 30,690 birds from 50 species in year 1, and 25,103 birds from 43 species in year 2. Dabbling ducks (20,000 total), and diving ducks (27,517 total), were the most abundant guilds across both years. We used multifactorial ANOVA to compare abundance of foraging or roosting dabblers, divers, and all birds, among study years, seasons (winter, spring), and tides. There were significantly more foraging birds in year 1 ($p < 0.05$), and more birds were roosting during winter ($p = 0.05$). We found significantly more foraging ($p < 0.01$), and roosting ($p < 0.01$), dabbling ducks in year 1. Foraging diving ducks were also significantly more abundant in year 1 ($p < 0.05$), and roosted more in winter than in spring ($p < 0.05$). We found no differences in abundance between high and low tide, potentially because water level, and therefore habitat availability, changed very little across the tidal cycle. Our results suggest that waterbirds, particularly dabbling and diving ducks, are responding to foraging and roosting habitat created by initial restoration of tidal flow to Cullinan Ranch. Continued efforts to understand habitat evolution and waterbird use of this site can inform adaptive management practices aimed at optimizing wetland habitat quality.

Keywords: salt ponds, north bay, waterfowl, shorebirds, tidal restoration

Poster Topic Habitat Restoration - Species and Communities

Managing Expectations - An Assessment of Land Use and Ecological Restoration in the Sacramento - San Joaquin Delta

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Decades of efforts aimed at improving aquatic and terrestrial ecosystems of the Sacramento - San Joaquin Delta and Suisun Marsh have failed to address declining species populations. Environmental planning and implementation actions undertaken to meet different policy objectives or legal requirements can create confusion over the meaning of ecological restoration and what outcomes should be expected. To provide clarity we evaluated land use and environmental projects within the region. We analyzed trends in urban, natural, and agricultural lands using development plans and Farmland Mapping and Monitoring Program data (1990-2014). We also reviewed the purpose and landcover characteristics of restoration projects (N=131) in the EcoAtlas database. Agriculture persisted as the dominant land use within the region, occupying 73.2% (555,800 acres) of the landscape in 2014, and declined 9.5% over the study period. Urban land use occupies 10.7% (81,200 acres) and increased 49.4%. Natural lands occupy 15.5% (117,900 acres) and have increased 21.4% over the study period. Importantly, using FMMP categories, natural lands are areas not in agricultural production, which generally exist in the linear margins of agricultural fields, on levees or leveed channel margins, or on instream islands. Environmental projects were largely focused (48%) on directly offsetting impacts through ESA/CESA or addressing them through ecological infrastructure (24%). Ecosystem services (e.g. carbon capture) accounted for 3%. Only 12% of were ecological restoration projects, with only 6 riparian or wetland projects with connectivity to riverine or tidal waterways. We posit that the efficacy of ecological restoration within the region is largely untested, given the past focus on maintaining baseline conditions. We suggest that policy and planning efforts aimed at recovery of ecosystem function and species populations leverage the rich systems-based science currently available and consider a robust concept of sustainable ecological restoration, implemented at biologically relevant scales.

Keywords: Restoration, agriculture, mitigation, planning, policy

Poster Topic Habitat Restoration - Species and Communities

Scaling Up Native Species Propagation Methods to Accommodate Large Transition Zone/Ecotone Projects of the Future

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Around the San Francisco Bay, project sites totaling approximately 35,000 acres of tidal marsh are currently awaiting restoration, many of which include large transition zone/ecotone habitats, a habitat type fundamental in protecting against sea level rise, providing wildlife refugia, and increasing biodiversity. Pilot projects to test methods for restoring baylands processes are a high priority, particularly to identify the most effective techniques to restore significant acreage in the face of sea level rise. The Oro Loma Horizontal Levee Demonstration Project constructed an ecotone slope at the Oro Loma Sanitary District facilities in San Lorenzo, CA. The ecotone slope was designed to serve as a buffer to impending sea level rise, test nutrient removal from wastewater discharge, and restore upland habitat.

The native plant propagation methods for the project were designed to "scale-up" and to reduce the cost of growing large numbers of plants in a traditional nursery setting. The entirety of the propagation cycle, including seed collection, was compressed from a typical 2-3 year timeline to one year. Over 70,000 locally-sourced plants were grown to vegetate the ecotone slope, utilizing various methods. The majority of plants were propagated vegetatively and rhizomatously at a division bed nursery constructed on the Sanitary District property within close proximity to the project site. Within the abbreviated timeline, the species chosen for the project thrived in the division bed nursery environment, were able to withstand the planting and harvesting process, and have successfully established on the newly graded slope.

The project established a low-cost, low-labor method for large-scale plant propagation and can inform propagation methods for future large-scale ecotone/transition zone restoration projects. The resilience and vigorous growth of the chosen species demonstrates the possibility of bulk propagation using small-scale farming methods to grow and transplant propagules for transition zone projects at a greater scale.

Keywords: Habitat restoration, Transition zone, Ecotone, Propagation, Tidal marsh

Poster Topic Habitat Restoration - Species and Communities

Funding Science & Restoration in SF Estuary Ecosystems: An Overview of New CDFW Grant Programs

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Numerous stressors have contributed to the decline in condition and function of key ecosystems throughout California, including the San Francisco Bay/ Sacramento-San Joaquin Delta (SF Estuary). The California Department of Fish and Wildlife is implementing three competitive grant programs to provide funding for multi-benefit ecosystem restoration and protection projects that contribute to efforts to reverse the impacts of these stressors.

The Wetlands Restoration for Greenhouse Gas Reduction Program was developed in 2014 to support projects that restore or enhance natural ecosystems in order to reduce greenhouse gas emissions and provide ecological co-benefits. This program is funded through the Air Resources Board's Cap-and-Trade Program as part of its overall greenhouse gas reduction strategy.

Two grant programs were developed in response to the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1): the Watershed Restoration Grant Program and Delta Water Quality and Ecosystem Restoration Grant Program. Proposition 1 provides funding to implement the three objectives of the California Water Action Plan: more reliable water supplies, restoration of important species and habitat, and a more resilient and sustainably managed water resource system (e.g., water supply, water quality, flood protection, and environment).

These grant programs are contributing to implementation of the California Water Action Plan, State Wildlife Action Plan, California EcoRestore, federal recovery plans, and other relevant State and federal initiatives. As of July 2017, a total of $96.1 million was awarded to 81 projects statewide, 22 of which ($34.1 million) occur within the Estuary. These SF Estuary projects include scientific studies designed to address priority science needs consistent with the Delta Science Plan, and projects to acquire important habitats, or plan and implement habitat restoration actions. Key activities of the grant programs will include tracking implementation and communicating outcomes to inform future management decisions.

For more information please see: www.wildlife.ca.gov/Explore/Organization/WRGB

Keywords: Watershed, Delta, funding, grants, science, habitat, ecosystem, salmon, smelt, fish

Poster Topic Habitat Restoration - Species and Communities

Proposition 1 Delta Conservancy Ecosystem Restoration and Water Quality Grant Program

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The Sacramento-San Joaquin Delta Conservancy (Conservancy) is a lead state agency in the implementation of ecosystem restoration in the Delta and supports efforts that advance environmental protection and the economic well-being of Delta residents. The Conservancy works collaboratively and in coordination with local communities, leading efforts to protect, enhance, and restore the Delta's economy, agriculture and working landscapes, and environment, for the benefit of the Delta region, its local communities, and the citizens of California. Voters approved the Water Quality, Supply, and Infrastructure Improvement Act of 2014 (Proposition 1) in November 2014. Proposition 1 identifies $50 million for the Conservancy "for competitive grants for multibenefit ecosystem and watershed protection and restoration projects in accordance with statewide priorities" (Sec. 79730 and 79731). The Conservancy's Proposition 1 Ecosystem Restoration and Water Quality Grant Program (Grant Program) has three programmatic focal areas: ecosystem protection, restoration and enhancement; water quality; and water-related agricultural sustainability. These focal areas directly align with several of the Estuary Blueprint goals such as 1) Sustain and improve the Estuary's habitats and living resources and 2) Bolster the resilience of Estuary ecosystems, shorelines, and communities to climate change. All proposed projects must be consistent with statewide priorities as identified in Proposition 1, the California Water Action Plan, the Conservancy's enabling legislation, the Delta Plan, the Conservancy's 2017 Strategic Plan, as well as applicable recovery plans. The Conservancy anticipates administering one grant cycle each fiscal year for at least five years, beginning in 2015. In its first two grant cycles, the Conservancy awarded $10.3 million of Proposition 1 funds for 12 eligible projects. This poster reports on the projects funded to date, their size and habitat type, their geographic distribution in the Delta, and highlights some of the challenges that have arisen during the granting process.

Keywords: Delta Conservancy, Proposition 1, Grant Program, Ecosystem Restoration, Water Quality

Poster Topic Habitat Restoration - Water Quality

Red Rock Warehouse Creosote Removal and Pacific Herring Habitat Restoration

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It is estimated that San Francisco Bay is littered with over 33,000 derelict pilings. Many of these pilings were treated with creosote to provide protection from decay in the marine environment. Creosote is toxic to marine organisms and fish, including pacific herring and their roe. The demolition phase of the Red Rock Warehouse project removed 450 derelict creosote pile from subtidal, intertidal, and upland areas along with other miscellaneous debris. The project scaled up previous creosote pile removal efforts in an attempt to make the process more cost effective. This poster provides a summary of the demolition phase of the project, lessons learned, an overall project update, and construction photos.

Keywords: creosote piling herring oyster restoration shoreline

Poster Topic Habitat Restoration - Water Quality

Marine Invasive Species in San Francisco Bay

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The Marine Invasive Species Program (MISP) is responsible for analysis of shipping vectors responsible for the introduction of non-indigenous species (NIS) into California's coastal waters. MISP has collaborated with the Smithsonian Environmental Research Center (SERC) and Molecular Ecology Laboratory at Moss Landing Marine Labs (MLML) to undertake an extensive program to analyze spatial and temporal patterns of NIS invasions in marine and estuarine waters of California.

The monitoring program included statistically robust field sampling, DNA-assisted taxonomic analyses, and data analysis. The surveys primarily focused on 10 estuaries or bays and high-salinity waters along the California open coast. Three communities were surveyed: hard substrate, soft-sediment, and plankton.

A combination of traditional morphologically-based taxonomy and molecular detection methods were used to identify the organisms collected. For each morphological voucher, corresponding molecular vouchers were also collected to verify species-level identity and build the DNA library.

In this poster, we present results from surveys of nine estuaries in comparison to San Francisco Bay, a culmination of a 5-year sampling program. We will present analyses of geographical distribution and patterns of spread for marine and estuarine NIS in San Francisco Bay; the mechanism(s) of introduction and spread from all 10 estuaries; and changes in the patterns (rate, spread, prevalence) of NIS in response to ballast water management strategies.

The details of the MISP program are on the Web at https://www.wildlife.ca.gov/OSPR/Science/Marine-Invasive-Species-Program

Keywords: Invasive species, non-indigenous, marine, monitoring, DNA, ballast water, taxonomy

Poster Topic Invasive Species

The Golden Bear Research Facility - Ballast Water Treatment System Testing in the San Francisco Estuary

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Ballast water from ships has long been recognized as an important vector for the introduction of aquatic invasive species (AIS) around the world. To lessen the threat, international, federal, and state regulations have adopted numeric ballast water discharge performance standards. In response, technology companies have developed numerous ballast water treatment systems (BWTS) that reduce the number of living organisms found in ballast water discharge. These BWTS must undergo rigorous land-based and shipboard testing to demonstrate their efficacy of treating for NIS before they are approved by the USCG or the IMO for use on vessels.

The Golden Bear Research Center (GBRC), located on the San Francisco Estuary, one of the most heavily invaded bodies of water in the world, is a research and development center at the CSU Maritime Academy that is committed to creating, promoting, and facilitating solutions to the maritime industry's current and future environmental challenges. Currently, our predominant focus is testing of BWTSs for IMO and USCG type approval. The Academy's training ship, the 500-foot *Golden Bear*, actively operates as a "plug and play" ballast treatment testing facility, allowing for both land-based and shipboard testing. In addition to testing technologies that will reduce the introductions of NIS, the GBRC provides an effective platform for the research, development, testing and evaluation of technologies and practices that reduce other environmental impacts from marine vessels, such as vessel biofouling, air emissions, and other effluents.

Keywords: ballast water, environmental testing, type approval

Poster Topic Invasive Species

Assessing Aquatic Plant Invasiveness to Facilitate Management in the Sacramento-San Joaquin Delta

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The California Department of Parks and Recreation's Division of Boating and Waterways (Division) is the lead agency of the state for the purpose of cooperating with other state, local, and federal agencies in identifying, detecting, controlling, and administering programs to manage, control, and when feasible, eradicate invasive aquatic plants in the Sacramento-San Joaquin Delta (Delta), its tributaries, and the Suisun Marsh. However, until 2015, the Division was authorized to treat only 3 aquatic invasive plant species*, Egeria densa, Eichhornia crassipes*, and *Limnobium laevigatum*, with each species having required legislation to do so. Recent legislative action (AB763; 2013) has reformed the mechanism for granting the Division the authority to treat additional invasive aquatic plant species in the Delta, now requiring that the California Department of Fish and Wildlife (CDFW), in consultation with partner agencies, conduct a risk assessment determining whether the aquatic plant is to be considered invasive. CDFW utilizes the U.S. Aquatic Weed Risk Assessment tool to assess the species' ecology, reproductive potential, dispersal mechanisms, competitive ability, resistance to management, and actual and potential impacts to navigation and recreation, health and stability, bird habitats, native plants, water quality, the economy, and human health, as specified in Harbors and Navigation Code (HNC) §64.5. To date, the Division has requested assessments of 6 aquatic plant species: *Potamogeton crispus, Myriophyllum spicatum, Ludwigia hexapetala, Ceratophyllum demersum, Cabomba caroliniana*, and *Hydrocotyle ranunculoides*. The first 5 species were determined to be invasive aquatic plants, per the invasive aquatic plant definition provided in HNC, and authorized for treatment within the Delta. *H. ranunculoides* is currently being assessed. Accuracy of the assessment tool, assessment questions, species scores, and overall findings will be presented.

Keywords: Invasive species, aquatic plants, Delta, management, risk assessment

Poster Topic Invasive Species

Storms, Droughts, Blobs and Invasions: Environmental Influences on Invasions in San Francisco Estuary Sessile Invertebrate Communities (2000 to 2016)

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Invasions by non-native species are well-known drivers of significant ecological change worldwide. Yet ecological communities are also strongly controlled by environmental conditions. Thus despite considerable available information on marine invasions in the San Francisco Bay region, it remains challenging to detect new invasions and estimate actual changes in invasion patterns, such as rate and spread. These data are key to understanding invasion processes and informing management and policy aimed at prevention of new invasions and responses to existing invasions. How do invasion patterns in the San Francisco Bay change over time, and how are they related to environmental changes?

We conducted repeated, standardized surveys of fouling communities throughout the San Francisco Estuary over a seventeen-year period spanning a wide range of environmental conditions, including two major droughts, several wetter winters, and a major marine heat wave.

Non-native species were prevalent throughout the estuary, but achieved greater dominance following dry winters. Community composition at any given site during the summer (May to October) was predicted by environmental conditions, especially the previous winter's precipitation (linked to salinity levels) and mean temperatures. Rarefaction analyses and richness estimators indicate that the number of species detected varied both as a function of the number of sites sampled in a given year and with environmental conditions, suggesting that standardized sampling across a broad range of conditions over time is needed. For years in which at least ten were sampled, an asymptote in estimated richness was reached, indicating statistically sufficient sampling to estimate the true richness of the community. In addition, several southern species were detected during a recent marine heat wave, suggesting a possible role of shifting conditions in facilitating potential new invasions. This large set of data allows us to better understand the influence of physical characteristics on invasion patterns in the San Francisco Estuary.

Keywords: Invasions, salinity, temperature, diversity

Poster Topic Invasive Species

A Classic Estuarine Lagoon of the 1960s Undergoes Oceanization by the 2010s: Remarkable Changes in the Biodiversity and Community Composition of Lake Merritt, Oakland, California

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Between 1962 and 1972 a detailed survey of the invertebrate, algal, and fish communities of Oakland's Lake Merritt, an estuarine arm of San Francisco Bay, was conducted by James Carlton. In September-October 2016, a re-survey of Lake Merritt was conducted by the Smithsonian Environmental Research Center to determine if and how the Lake's biodiversity may have changed over the past 50 years. Experimental panels were deployed at piers (three months earlier) and shallow-water soft sediment samples were taken around the Lake's perimeter at the same stations sampled by Carlton in the 1960s for biofouling and infaunal communities. Former lake-wide reefs of the introduced brackish-water Australian tubeworm *Ficopomatus enigmaticus* have been largely replaced by reefs of the introduced Mediterranean marine mussel *Mytilus galloprovincialis*. Seawall zonation of the 1960s consisting of a higher intertidal zone of the introduced barnacles *Amphibalanus improvisus* and *A. amphitrite*, a mid-zone of *F. enigmaticus*, and a lower zone of the brackish-water Atlantic mussel *Geukensia demissa* now consists of an upper zone of barnacles and a lower zone of *M. galloprovincialis*. At least 12 introduced species of marine ascidians and bryozoans, none present in the Lake 50 years ago, now characterize biofouling communities. Masses of the introduced "spaghetti weed" bryozoan *Amathia verticillata* were found to impede tidal flow at the Lake's flood control station. Vast carpets of the introduced seaweeds *Lomentaria hakodatensis, Gracilaria* sp., *Sargassum muticum,* and *Codium fragile fragile* covered the shallow floor of the Lake; only small colonies of the latter were present in the Lake in the 1960s. Remnants of the 1960s communities remained on seawalls at the tips of the brackish arms of the Lake. We discuss changes in the Bay's hydrography and salinity regimes, and the modern history of Lake water management, that may have led to the oceanization of Lake Merritt.

Keywords: monitoring, climate change, invasive species, Lake Merritt, oceanization, estuarine lagoon

Poster Topic Invasive Species

Survival of the *Gemma gemma* Clam in Low Salinity Conditions: Field and Laboratory Observations

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Massive precipitation experienced in California during the 2016-17 winter brought the salinity of surface waters in San Francisco Bay down to values not seen in years. Bay-dwelling organisms such as intertidal clams are at risk of mortality in salinity conditions that exceed their tolerance limits. While some fluctuation in salinity and other environmental conditions is a staple feature of estuarine life, extreme conditions – such as this past winter's low salinity – may present an exceptional stress. The introduced clam, *Gemma gemma*, is a prominent member of Bay mudflat clam communities whose range may increase within SF estuary should drought conditions in CA become the norm, but its responses to low salinity extremes are poorly known.

Observations from the field and in the laboratory provide insight into the role of salinity on the distribution of *G. gemma* in SF estuary. A field study conducted at six sites along a salinity gradient between Richardson Bay and San Pablo Bay revealed a trend in decreasing abundance of *G. gemma* populations with increasing distance northward from the Golden Gate Bridge. The lack of *G. gemma* at the least saline sites in San Pablo Bay was reflected by the higher mortality observed in laboratory treatments where salinity was less than ten. In the long run, reduced availability of freshwater flow from the SF Delta due to future drought and diversions may increase the likelihood of the spread of *G. gemma* to regions upstream from its current distribution. Yet this spread may be counteracted by occasional extremely wet winters – like this past winter.

Student Award Competition: Yes

Keywords: invasive species, salinity tolerance, wet winter mortality, mudflat, intertidal

Poster Topic Invasive Species

The Impact of Invasive Aquatic Vegetation on Turbidity and Marsh Accretion in the Sacramento-San Joaquin Delta

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Invasive aquatic vegetation (IAV), dominated by Brazilian waterweed (*Egeria densa*), water hyacinth (*Eichhornia crassipes*), and water primrose (*Ludwigia* spp.), is acting as an "ecosystem engineer" in the Sacramento-San Joaquin Delta (hereafter, Delta) in part by altering sediment transport. In 2015, IAV covered nearly 1/3 of the Delta's waterways. We hypothesize that long-standing, widespread presence of IAV is reducing vertical accretion on marshes and impacting fish habitat quality by reducing water column turbidity. In this project, we are determining the impact of IAV on sediment dynamics in flooded island, channel, and between island sites chosen using remotely-sensed imagery of the Delta. The objectives of the project are (1) to determine the effect of IAV on sediment flux and sediment trapping using (a) measurements of sediment flux along transects landward and seaward of IAV patches and (b) time-series measurements of velocity and suspended-sediment concentration (SSC) within and outside IAV patches, and (2) to determine the impact of IAV on inorganic sedimentation by measuring short (1-2 years) and long-term (past 50-100 years) vertical accretion in marshes situated adjacent to IAV.

To date we have collected transect data in Lindsey Slough and the Mokelumne River. Preliminary results suggest that there are strong horizontal gradients in suspended sediment flux near IAV patches. At Lindsey Slough, ten days of velocity and SSC data were collected within a Brazilian waterweed patch, and in the adjacent channel. Average SSC in the patch was reduced by 10-20%, compared to the channel. Currents were almost completely damped by the vegetation. Future work will focus on additional sediment flux measurements and measuring inorganic sedimentation in marshes adjacent to IAV. The ultimate goals of the project are to quantify the entire Delta sediment sink under IAV and determine the relative impact of long-term IAV infestation on marsh accretion rates.

Keywords: invasive aquatic vegetation, *Egeria densa*, sediment dynamics, vertical accretion

Poster Topic Invasive Species

Exploring the Distribution of an Invasive Crab and Its Impact on Cordgrass Restoration in San Francisco Bay

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Predators structure ecosystems by interacting with other trophic levels directly and indirectly. These indirect interactions can have large effects, yet are understudied in the context of restoration. We explored how predators, among other environmental factors, may impact crab distributions in the intertidal zone, and potential consequences of the resulting distributional shifts on restoration efforts of the native cordgrass (*Spartina foliosa*) in San Francisco Bay. Perceived threat from or direct consumption by subtidal predators at low tidal elevations, or other environmental factors, may cause *C. maenas* to seek refuge in high tidal elevations. These areas may include restored cordgrass habitat where crab foraging activity may cause damage. Crab distribution and predation on crabs were quantified using trapping and tethering experiments across tidal elevations. We then evaluated the effects of crab activity within *S. foliosa* patches using a field enclosure experiment, caging newly planted cordgrass with and without crabs to assess impacts on cordgrass growth and survival.

Caged treatments with green crabs had significantly fewer *S. foliosa* shoots at the end of a three-month period than plots without cages or crabs, suggesting that crab presence may hinder successful *S. foliosa* establishment. This work has important implications for management as interactions between multiple trophic levels can confound restoration efforts but are rarely considered in restoration settings. Illuminating the intricacies of species interactions will make future restoration attempts more efficacious and informed.

Student Award Competition: Yes

Keywords: invasive species, restoration, cordgrass, European green crab, trophic interactions

Poster Topic Invasive Species

The Direct Economic Costs to Manage Invasive Aquatic Weeds in the Bay-Delta

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Water hyacinth and Brazilian waterweed are two aquatic weeds of economic importance in the Bay Delta. Between 2013 and 2016 there was an explosion of water hyacinth in 2014 and 2015, followed with much smaller infestations in 2016. This explosion was met with a significant increase in management by those businesses and agencies whose activities were affected by the water hyacinth infestations. Considerable management costs were incurred by the U.S. Bureau of Reclamation Tracy fish facility where weeds had to be extracted from the river before water could be pumped into the California aqueduct; marinas to prevent boats from being blocked in docks; and the Port of Stockton to keep commercial shipping viable, among others. In addition it made the cost to protect human health more expensive as mosquitos can use water hyacinth mats as breeding areas. Treating mosquitos to prevent the spread of West Nile Virus may then rise when large mats of water hyacinth are present. Finally, during the last several years night time navigation on the deep river channel between Oakland and Stockton was suspended from October through February due to thick densities of water hyacinth that can interfere with a ship's radar.

Between 2013 and 2016 the total cost to manage invasive aquatic weeds by the agencies and businesses affected by infestations was $5.84 million. Almost half of that cost was incurred by the U.S. Bureau of Reclamation at $2.75 million, followed closely by marinas at $2 million. In 2016, due to a combination of improved rainfall and management in the previous years, total costs fell by 21%. However, the cost decreases were due primarily to lower costs to manage water hyacinth, as costs by marinas to manage Brazilian waterweed increased.

Keywords: Water hyacinth, Brazilian water weed, management, costs

Poster Topic Invasive Species

Controlling Algerian Sea Lavender in San Francisco Estuary Tidal Marshes

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Algerian sea lavender [*Limonium ramosissimum* (LIRA)] is an invasive plant spreading in tidal marshes of both northern and southern California. LIRA is one of four noxious weeds listed as the Highest Priority for management in the South San Francisco Bay Weed Management Plan (2013) prepared by the Don Edwards San Francisco Bay National Wildlife Refuge. It is also the least widespread of these four priority weed species, offering the best opportunity for a successful Early Detection/Rapid Response program.

Infestations of LIRA in the Estuary have been well studied by two graduate students in Dr. Katharyn Boyer's lab at San Francisco State University (Gavin Archbald and Kerstin Kalchmayr). LIRA was found to produce an estimated 36,000 to 130,000 seeds per m^2, and grow most vigorously (and produce the most seed) at the tidal elevations found in the high marsh and the estuarine-terrestrial transition zone, precisely the tidal areas in shortest supply due to impacts from development over the last century. Replacement of native plants such as *Grindelia stricta* (gumplant), *Frankenia salina* (alkali heath), and *Distichlis spicata* (saltgrass) with short rosettes of LIRA is unlikely to provide comparable refugia from predators, especially at high tides when endangered species such as California Ridgway's rail and salt marsh harvest mice are most vulnerable.

Mapping showed an increase from 15,000m^2 in 2008 to 32,000m^2 in 2015 (113% increase; a conservative estimate), and LIRA was also found in an additional 45 locations in the Estuary. With funding from the National Fish and Wildlife Foundation, the California Invasive Plant Council began a two-year pilot project in 2016, treating invasive *Limonium* at 15 sites in Alameda, Marin, and San Mateo Counties using chemical and manual control methods. Test plots were also established to evaluate the efficacy of imazapyr, glyphosate, and a combination of both active ingredients.

Keywords: *Limonium ramosissimum*, invasive sea lavender, tidal marsh, herbicide treatment

Poster Topic Invasive Species

Decreasing the Risk of Aquatic Species Invasion from Vessels Arriving at Bay-Delta Ports

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Nonindigenous species (NIS) are organisms introduced through human activities to an area where they do not naturally or historically occur. Once established, NIS can have ecological, economic, and human health impacts on the receiving environment. The coastal waters of California are some of the most invaded areas of North America, roughly 89% of western North America's currently established marine NIS were first documented in California. In coastal environments, the commercial shipping pathway has contributed up to 79.5% of NIS introductions to North America and 81% in California. Commercial vessels transport organisms through ballast water and biofouling vectors. The California State Lands Commission's Marine Invasive Species Program (MISP) is responsible for preventing or minimizing the release of NIS from vessels that are 300 gross registered tons and above. To assess the likelihood for vessels to introduce NIS into California waters and/or spread NIS to other areas, an examination and analysis of vessels' NIS management practices and their previous and subsequent ports of call was conducted for the seven port zones within the Sacramento/San Joaquin Delta and the San Francisco Bay. Understanding ballast water and biofouling management patterns and the movement of vessels can inform risk management strategies to decrease the introduction, establishment, and spread of NIS.

Keywords: marine invasive species nonindigenous aquatic vector prevention ballast water biofouling

Poster Topic Invasive Species

Innovative Techniques for Removal of *Arundo donax* in the Sacramento/San Joaquin Delta, Solano County, CA

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The invasive plant *Arundo donax* has become widespread in California. The Sacramento-San Joaquin Delta Conservancy and the California Department of Water Resources have begun an initiative to eradicate *Arundo* from the California Legal Delta. In 2015 the Sonoma Ecology Center was contacted to map and prioritize *Arundo* eradication throughout the Delta. Eradication of *Arundo* along levees can be difficult due to access constraints, steep slopes, and large stands that are approachable only on one side. In 2016 and 2017, Sonoma Ecology Center began *Arundo* eradication efforts in Solano County using a novel technique. Combining a hydraulic lift with a telescoping boom and a truck-mounted spray rig, we have been able to gain access to large stands of *Arundo* along levees and other difficult to reach locations. This innovative technique allows us to spray directly onto the invasive foliage from above, while minimizing over-spray and impacts on surrounding native vegetation. The submitted poster provides detailed images of the lift and spray-rig in action.

Keywords: *Arundo donax*, invasive species, eradication, restoration, habitat

Poster Topic Invasive Species

Biotic Filters Shaping *Limonium* Invasion in San Francisco Bay Salt Marshes

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Coastal salt marshes in San Francisco Bay have seen aggressive expansion of invasive plants, displacing native species and the broader communities and functions they support. Three recent invaders–*Limonium ramosissimum*, *Limonium duriusculum*, and a third, unidentified species–thrive in the mid to upper salt marsh and marsh-terrestrial ecotone. These areas host high species richness and provide critical habitat for endangered vertebrates. Marsh patches containing invasive *Limonium* have experienced a marked decline in native halophytes, including the only *Limonium* native to California: the Western marsh rosemary, *Limonium californicum*.

My project investigates the relative invasion potential of three *Limonium* species via vegetative competition and pollinator interactions. Given the spatial proximity and relatedness, the congeners likely influence each other's growth and compete for resources. I grew pairwise combinations of invasive seedlings watered with high and low salinity water to assess differences in vegetative growth. I also set up treatments with two-year-old *L. californicum* paired with seedlings of each invader to simulate new introductions and quantify effects on growth of the native. Furthermore, pollinators such as bees visit both native and invasive *Limonium;* the reproductive mechanisms for these species are still unresolved, and shifting pollinator habits may favor the spread of one species over another and increase interspecific pollen transfer. Through controlled pollinations in the greenhouse, I will determine whether each species is self-compatible, how interspecific pollen affects seed production, and whether or not hybridization is possible.

This research explores multiple ways in which invasive *Limonium* may outcompete native species and alter salt marsh biodiversity. If I find that one species is dominant or hybridization occurs, my results can direct managers on the targeted removal of any or all invaders. My investigation will also provide a mechanistic understanding of wetland invasion more generally and provide new information about the reproductive strategies within the highly-variable *Limonium* genus.

Student Award Competition: Yes

Keywords: *Limonium*, salt marshes, invasive species, wetland pollinators

Poster Topic Invasive Species

2017-2021 Science Action Agenda: A Collaborative Roadmap for Delta Science

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Although several collaborative organizations exist in the Delta, there has been no shared science agenda that lays out common priority science needs, questions, and actions. This has made comprehensive and efficient science planning, funding, coordination and integration difficult, while critical science gaps persist. The 2017-2021 Science Action Agenda (SAA) addresses this issue through prioritizing and aligning near-term science actions to inform management and policy decisions. The SAA is a four year science agenda intended to fill gaps and serve as the glue for synergistic and multi-benefit science to support important management needs. Thus, actions identified in the SAA are those that fall between the mission statements and priorities of a single group, program, or agency but are otherwise recognized as cross-agency and multi-group priorities.

The 2017-2021 SAA identifies 13 high-priority science actions in five thematic actions areas that were identified through an open and transparent prioritization process. This collaborative effort involved input from the Delta Science community, major synthesis efforts, key peer-reviewed literature, public comments, and Delta Independent Science Board review. The priority actions address needs that go beyond the Delta and provide benefits for the San Francisco Bay-Delta Estuary. Examples of priority science activities that link the Bay and Delta include restoring habitats on a landscape scale, modernizing monitoring efforts and tools, advancing integrated modeling efforts, and exploring the human-dimensions of natural resource management. The Comprehensive Conservation and Management Plan also served as a source document for actions identified in SAA and the two documents share similar themes including restoration of tidal habitats, understanding effects of invasive species, and developing comprehensive research and monitoring programs.

Keywords: science action agenda, collaborative science, delta science program

Poster Topic Public Outreach

Delta Plan Performance Measures

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There's a Performance Measure for that… you've heard the mobile commercials from finding the nearest dog park, to shopping online, to tracking your spending, "there's an app for that". Well, some may be surprised to know that the practice of developing performance measures for Delta Plan co-equal goals has become as important as developing a new app. Performance Measures track progress on how are we doing in implementing the Delta Plan, a comprehensive, long-term management plan for the Delta. Here at the Delta Stewardship Council, we have developed a set of performance measures: administrative to report on decisions, resources and implementation of a programs or plans; output measures to track on-the-ground implementations; and outcome measures to evaluate specifics responses to management actions. Tracking progress through Delta Plan performance measures aids in sustaining and improving the Delta habitats and living resources, reliable water supply for California, and protecting the Delta as an evolving place. So when one thinks about progress towards sustainability or improving functionality. Remember, there's a Performance Measure for that.

Keywords: tracking, performance measure, performance measures, implementation, delta plan, co-equal goals

Poster Topic Public Outreach

Heavy Rainfall Follows Record Drought: Changes in Lake Merritt

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The purpose of our research was to investigate the effect of the heavy rainfall in 2017 on water quality in Lake Merritt, a tidal lagoon in the middle of heavily urbanized Oakland, CA. Specifically, how were water temperature, salinity, transparency, pH, and dissolved oxygen (D.O.)—important indicators of lake health—affected by the increased rainfall brought by 2017's atmospheric rivers?

Water quality measurements have been taken weekly by classes of Oakland High School students from 1997-2017. Water was collected by grab sampling from the top of the water column and by using a LaMotte Dissolved Oxygen Water Collector to sample from the bottom. Students used simple instruments: an alcohol thermometer for air and water temperature, a salinity refractometer, a Secchi disk for transparency, pH strips, and CHEMets D.O. vacuum ampoules for dissolved oxygen.

We compared the water quality indicators (January to April) for three years - 2015 (drought), 2016 (El Niño) and 2017 (extreme rainfall) at shore and mid-lake stations. We found significant decreases in salinity and warmer water temperatures in 2017 compared to 2015 and 2016. Dissolved oxygen was lower in 2017 than in 2016. Very low salinity during February 2017 rains, tide gate closures and other urban runoff factors, probably worsened the annual die-off of marine-adapted organisms and possibly triggered a die-off of bat rays.

While atmospheric rivers have long been a feature of California weather, climate models predict that they will increase in frequency in the future. Monitoring the water quality of Lake Merritt is needed to understand better how changing weather patterns in our estuary will affect habitats and species. In the face of further environmental change, it will become only more necessary that we conserve the health of our wetlands and demand that government take action against climate change.

Keywords: water quality, atmospheric rivers, salinity, dissolved oxygen, Lake Merritt, drought

Poster Topic Public Outreach

Oakland Adopt a Drain Volunteers Prevent Flooding and Improve Water Quality by Keeping Storm Drain Inlets Clean and Clear

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The City of Oakland Public Works' Adopt a Drain program supports volunteer efforts to keep storm drain inlets clean and clear of trash and debris. Ensuring "only rain down the drain" is especially helpful during storms when blocked storm drains can back up and cause flooding. Year-round storm drain maintenance helps intercept trash before it pollutes downstream waters.

The City of Oakland provides support for Adopt a Drain volunteers through instruction, tools and supplies, assistance with debris pickups, and notification of impending storm events.

Over 1,000 of Oakland's approximately 7,500 storm drains have been adopted. The more than 800 Adopt a Drain volunteers greatly supplement the capacity of the twenty City staff servicing the storm drain system, with its more than 7,500 storm drains, 370 miles of drain pipe, seven pump stations and 40 miles of creeks. Volunteers can quickly and preemptively provide basic maintenance on drains and can have a far more extensive and immediate reach across the city than staff during storm and flooding emergencies.

Oakland uses a map interface at www.AdoptaDrainOakland.com for depicting the City's storm drain inlets to the public for possible adoption. This easy to use interface has helped spur new volunteer registrations. Social media, word-of-mouth, and timely news coverage prior to and during storm events has also contributed to volunteer registrations.

www.AdoptaDrainOakland.com was created in partnership with Open Oakland, a group of civic minded volunteer computer programmers. The map can be updated in real time to show storm drain system changes and adoptions. The open source software is being adapted freely by other municipalities. A multi-city collaboration has been formed to update this platform for the benefit of all municipalities.

Oakland has developed additional resources such as outreach and instructional flyers that are also available to other municipalities. More info at www.oaklandadoptaspot.org and www.AdoptaDrainOakland.com.

Keywords: storm drain, volunteer, trash, water quality, social media, flooding, www.oaklandadoptaspot.org

Poster Topic Public Outreach

Wintering Waterfowl Avoidance and Tolerance of Recreational Trail Use

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We used an experimental approach to investigate wintering waterfowl responses to introduced trail use at foraging sites with and without recreational trails in California, USA. Waterfowl were exposed to trail use in the form of two researchers walking levees adjacent to ponded habitat, and the number of waterfowl by species were compared before versus after experimental walks in 40-m bands starting at the levee and extending 200 m into the ponds. We recorded distances to the nearest individuals, responses of focal animals, and numbers of recreational trail users. The most numerous species were Ruddy Duck (*Oxyura jamaicensis*), Northern Shoveler (*Anas clypeata*), and scaup spp. (*Aythya affinis* and *A. marila*). At trail sites, recreational use averaged 1 to 82 people/hr. The greatest difference in numbers of birds before vs. after experimental walks occurred in the two 40-m bands closest to the levee at both non-trail sites and trail sites. Neither the response of birds over the winter season nor the total number of birds vs. the number of recreational trail users indicated increasing tolerance to trail use for waterfowl overall. However, species varied in their tolerances. Ruddy Duck numbers declined with increasing numbers of recreational trail users, while Northern Shoveler numbers increased. Based on distances individual birds stayed from researchers during our walks, we suggest managers consider putting new trails approximately 200 m from wintering waterfowl foraging habitat to reduce or avoid immediate impacts to waterfowl.

Keywords: avoidance, ducks, habituation, human disturbance, tolerance, trail, waterfowl, wintering

Poster Topic Public Outreach

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

Relocating a Historic Cormorant Nesting Colony through Implementation of Nesting Platforms on New East Span of the San Francisco-Oakland Bay Bridge

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Since 1984, double-crested cormorant (*Phalacrocorax auritus*) nesting has been documented on the underside of the original east span of the San Francisco-Oakland Bay Bridge (SFOBB). By 2007, the SFOBB colony had grown to become one of the largest in Northern California with more than 800 nests. Following the Loma Prieta Earthquake in 1989, the California Department of Transportation (Caltrans) began the planning that would ultimately lead to the replacement of the original east span. Recognizing that demolition of the original east span would remove what had grown to become a critical local nesting site for the species, Caltrans decided to construct nesting platforms along the middle of the skyway on the new east span in the hopes that the colony would relocate. The new nesting platforms were completed in 2009 and enticements were installed with the goal of relocating the colony to the new location. Enticements included cormorant decoys, audio broadcasts of cormorant calls, faux nests, nest boxes, and mirrors designed to mimic greater density on the platforms. However, as demolition of the original span began in 2014, the new nesting platforms sat unused as the colony held onto the remaining sections of the original east span. On March 28, 2017, the final span of the original bridge superstructure was lowered, effectively removing the colony's historic habitat. On April 5, 2017, the first cormorant observations on the new platforms were recorded. By May 2017, approximately 600-700 birds were observed roosting and nesting on the new platforms. The double-crested cormorants observed are likely the same population that were using the original east span. Next steps include continued maintenance of the nesting platforms and possibly removal of the enticements that would be unnecessary after the colony has established itself on the new platforms.

Keywords: Bay Bridge, cormorant, nesting, habitat, bird, Caltrans

Poster Topic Species and Communities

Canvasback Movement Patterns and Space Use in Suisun Bay and Marsh

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Suisun Bay and Marsh are integral components of the San Francisco Bay Delta ecosystem and have a long history of waterfowl use. Diving ducks, including canvasback (*Aythya valisineria*) are numerous in Suisun throughout winter, and previous work has demonstrated exchange of diving ducks between Suisun and other SFB sub-bays; however, what drives movement among these sub-bays is unclear. In addition, little is known about habitat use or food quality and availability for diving ducks using Suisun. Our study is designed to evaluate diving duck use of Suisun Marsh and Bay with the ultimate goal of identifying management regimes that may benefit these species. As part of this comprehensive study, we evaluated canvasback movements and space use during winter 2016 and 2017. We captured 33 canvasback in Suisun Bay and Napa-Sonoma Marsh using baited swim-in traps and fitted them with GPS-GSM tracking devices that provide high resolution location estimates. We used continuous-time stochastic Brownian bridge movement models (package BBMM in R 3.0) to evaluate canvasback movements across winter and during spring migration. We also calculated fixed kernel densities at the collective and individual level to evaluate space use. Initial results show differential movement and use patterns between the two study years. In 2016, individuals used a full spectrum of Suisun habitats including shallow shoals, tidal marshes, managed marshes, and static deep-water ponds, and transitioned inland towards freshwater habitats during spring months. Whereas, in 2017 canvasback use of Suisun habitats was limited and individuals moved inland to the Central Valley in early winter, potentially as a result of historic fresh water availability. Given cyclical drought conditions, planned tidal wetland restoration and diminishing freshwater flows to this region, information on diving duck ecology in Suisun can improve our understanding of how projected habitat changes may influence these species in the future.

Keywords: waterfowl, telemetry, habitat use, restoration, drought, freshwater flows

Poster Topic Species and Communities

Suisun Marsh Waterfowl and Managed Wetland Research Program

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In 2014, the Department of Water Resources (DWR) established the Suisun Marsh Waterfowl and Managed Wetland Research Program to help achieve regulatory requirements while providing data on key biological uncertainties with the overarching goal of improving the management of managed wetlands (duck hunting clubs) to sustain populations of waterfowl and other native species. DWR has developed 10 year contracts with the USGS and UC Davis with the goal of understanding the management needs of waterfowl, native fish, Salt Marsh Harvest mice, Black and Ridgway's Rails, Western Pond Turtles, and raptors in the Suisun Marsh. To date we have attached cellphone tower transmitters on 7 species of waterfowl to document winter habitat use and movements, and on 3 species of waterfowl to evaluate breeding season habitat use and movements. We have deployed audio-detection devices to aid in detecting rails, evaluated Salt Marsh Harvest Mouse use of managed wetlands, and are in the first year of working with UC Davis and USGS to conduct Western Pond Turtle Surveys and Northern Harrier surveys. We will initiate telemetry studies on both species in 2018. Recognizing that to be successful we have to work with over 100 duck hunting clubs in the Suisun Marsh, we have also launched a Human Dimensions study to better understand what may inhibit landowners from implementing management practices on their duck hunting club. For example, is it cost, how the message is delivered, views towards who is delivering the message, or simply attitudes towards conservation and research? Future work includes, examining the role managed wetlands may play as exporters of nutrients (i.e. food) for native fish, and gaining a better understanding of how skunks, raccoons, and other predators of nesting waterfowl and Salt Marsh Harvest mice use the Marsh.

Keywords: Suisun Marsh, Waterfowl, Managed Wetlands, Habitat Management

Poster Topic Species and Communities

Environmental Drivers of Macroinvertebrate Biomass and Waterbird Abundance in Managed Ponds of South San Francisco Bay

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The South Bay Salt Pond Restoration Project, the largest tidal marsh restoration effort on the North American Pacific coast, was initiated in 2007 to restore 50-90% of former salt ponds and benefit tidal marsh species that lost much of their historical habitats. The Project must balance the needs of species that require vegetated tidal marsh with those of waterbirds that depend on non-vegetated mudflats and managed ponds. To inform future management actions designed to sustain foraging and roosting waterbirds, we evaluated waterbird and macroinvertebrate responses to experimentally manipulated water depth and salinity in managed ponds at Eden Landing Ecological Reserve in South San Francisco Bay. We observed 39 species of waterbirds from 11 guilds. The abundance of guilds differed among salinity treatments; small shorebirds were most abundant at high salinities (80 – 120 ppt), medium shorebirds were most abundant at moderate salinities (40 – 80 ppt), and dabbling ducks were most abundant at low salinities (< 40 ppt). Overall, small shorebirds were the most abundant guild, and were strongly influenced by the elevation and exposure of sediment mounds in the ponds. Interestingly, we did not detect a relationship between the abundance of foraging small shorebirds and macroinvertebrate biomass on sediment mounds, suggesting that other factors, such as predator avoidance, may be important drivers of foraging shorebird abundance. Macroinvertebrate biomass was weakly affected by water depth, with the greatest biomass of macroinvertebrates observed at water depths between 10 and 20 cm. This depth is inaccessible to most small and medium shorebirds, suggesting that predation may play a role in limiting macroinvertebrate biomass at shallower depths. Our results support the idea that managing ponds at different salinities and at water depths that maximize the accessibility of mounds could maintain high abundances of foraging and roosting birds from a broad suite of guilds.

Keywords: Foraging ecology, Macroinvertebrate biomass, Salt ponds, Waterbirds, Wetland restoration

Poster Topic Species and Communities

PCB Tissue Concentrations and Benthic Community Impacts at a Carbon Amendment Pilot Study in the Intertidal and Subtidal Zones of San Francisco Bay

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Historical site activities at the Hunters Point Naval Shipyard (HPNS) in South San Francisco Bay resulted in the release of chemicals, including polychlorinated biphenyls (PCBs), to offshore sediments. To inform remedy selection at this urban site, activated carbon (AC) amendments alternatives were evaluated in a pilot treatability study. Two 0.4 acre plots extending from the intertidal to the subtidal zone were treated with either AquaGate + PAC™ or SediMite™ were assessed for their potential to reduce ecological risks associated with PCB-contaminated sediment. Previous treatability studies indicated that AC may be effective at reducing the bioavailability of PCBs to the bent-nose clams (*Macoma nasuta*) in shallow intertidal sediments when aided by mechanical mixing. This study assessed the effectiveness of AC placements without mechanical mixing in deeper water that is more representative of conditions where full-scale remediation is expected. Tissue bioaccumulation, benthic invertebrate community composition, and chemical analyses were measured as indicators of remedy effectiveness. Comparisons were made between baseline, reference, and post-amendment conditions (8 months and 14 months post-placement). PCB tissue concentrations in *Macoma* sp. were measured *in situ* and *ex situ* (bench-top) after 28-day exposures. Developing field exposure chambers that allowed sediments to infiltrate the chambers and expose clams upon deployment and then retrieve the sediment and exposed organisms for chemical analyses was a challenge. Modifying a chamber design used in previous studies by Luthy et al. (2009) proved successful. PCB tissue concentrations were reduced up to 85% in both pilot amendment areas after 14 months with survival greater than 90 percent. Benthic invertebrate communities in test plots were not significantly different from baseline conditions or among treatments 14 months after AC deployment.

Keywords: PCBs, benthic community

Poster Topic Species and Communities

Declining Productivity of Brackish Marsh Plants with Increasing Inundation and Salinity in Suisun Bay

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Inundation and salinity are important drivers of plant distribution and productivity in tidal marshes. Plant physiological stress due to these factors may increase with sea-level rise in the San Francisco Bay-Delta Estuary. We tested the response of several dominant brackish tidal marsh species to elevated salinity and inundation using greenhouse and field experiments during the 2016 growing season. In the field, we grew a high marsh species, *Juncus balticus*, in mesocosms at a range of elevations that varied tidal inundation (5 levels) and at three different initial soil salinities. Under ambient soil salinity, productivity varied unimodally with inundation, peaking at intermediate flooding duration. There was a similar functional relationship between productivity and inundation at higher initial soil salinities, but peak productivity shifted to slightly lower elevations and was reduced in high marsh relative to ambient soil salinity. In the greenhouse we grew potted cuttings of *J. balticus*, *Schoenoplectus americanus*, and *Schoenoplectus acutus* in salinity baths ranging from 0 to 30 ppt to evaluate inter-specific differences in growth responses of these species to salinity stress. Soil salinities in the experiment exceeded salinities in the water baths. Productivity of all species was highest at low salinities (nominal salinity of 0-2 ppt in water baths) and declined several fold in the highest salinity baths. *S. americanus* appeared to be most tolerant to intermediate salinities (10 ppt in water baths), a salinity level that might become more frequent in the Suisun Bay region with future sea-level rise. Our results show that increasing salinity can affect species differently and modify plant growth responses to inundation. Relative sea-level rise could therefore potentially affect vegetated marsh productivity and the relative competitive ability of species as marshes become more submerged and more saline into the future.

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

Poster Topic Species and Communities

Celebrating 30 years of Francisco Bay Wildlife Society: A pilot study on Macroinvertebrate Recolonization at the Bottom of Dredged Stockton Ship Channel, in the California Delta

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San Francisco Bay Wildlife Society has been improving our Estuary for 30 years, including Environmental Education, Research, and Restoration. SFBWS now seeks more science advisors.

California's extensive, marshy Delta includes two largely overlooked, 10~13 -m-deep freshwater ship channels, with portions dredged every 1~>5 years, with macroinvertebrates eaten by protected and other fishes. We hypothesized macroinvertebrates to recolonize slowly after maintenance dredging, with recolonization possibly slowed due to repeated disturbance from large ships passing.

We first tested disturbance to these invertebrates as large ships passed. Remote underwater wide-angle-cameras placed near passing ships, generally showed ship hydrodynamics minimize such bottom disturbance. Narrow channels and side channels focus displaced water into brief erosional currents, yet benthic individuals persisted even there.

Rather than traditional annual sampling for recovery (e.g. from dredging,) we applied approaches from "old-field succession," simultaneously comparing populations at similar channel sites dredged at different times into the past, also compared to naturally deep, never dredged, sites nearby. The latter sites showed periodic erosion and coarser sediment, less comparable to dredged sites upstream. But sites dredged most recently (even 3~9 months earlier) also showed large populations and even large individuals of diverse invertebrates, approaching those in nearby, similar sites not dredged in >5 years, and as dense as even the naturally deep, never dredged sites. Overall population densities averaged ~2000 individuals per m^2, including common tubificid worms, amphipods, and clams.

Rapid reappearance of invertebrates after this maintenance dredging may arise from observed drift of shallow vegetation, with dense attached invertebrates, from animal transport from ~2 kt tidal currents, and from "topsoil" slumping into the channel after this form of maintenance dredging at the edge of the ship channel.

Keywords: California Delta, ship channel benthos, fish food resources, invertebrates

Poster Topic Species and Communities

Macroinvertebrate Prey Availability for Fish in Periodically Dredged Areas of Central San Francisco Bay

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Periodic, shallow-water maintenance dredging is necessary to maintain waterways, but it can also remove patches of habitat and disturb benthic macroinvertebrate communities that provide important prey resources for many economically and ecologically important fish species. However, there is a lack of information specific to the San Francisco Bay (SFB) on the degree of benthic community disruption caused by dredging. The goal of this on-going study is to provide insight on the extent to which dredging impacts macroinvertebrate prey resources in bottom-dwelling fish foraging habitat in Central SFB. We are comparing macroinvertebrate communities between periodically dredged (every 1-3 years) and adjacent undredged areas. Benthic core samples are being collected from six shallow (<3.96 m MLLW), soft-bottom (silt/clay soil texture) environments in Central SFB during summer and winter over two years. To assess foraging habitat for key fish species, we are measuring prey abundance, biomass and accessibility. We assume accessibility is limited by macroinvertebrate size (i.e., fish gape size dictates the size of prey consumed) and the depth at which prey occurs in the sediment (i.e., foraging strategies determine if fish can access upper or deep sediments). Thus, we are dividing benthic core samples into shallow (0-4 cm) and deep (4-10 cm) segments, and categorizing identified prey into size classes. Preliminary results suggest macroinvertebrate abundance differed significantly between paired dredged and undredged areas, and by depth category. This study will help clarify whether areas that are dredged periodically have different macroinvertebrate prey availability for fish compared to adjacent undredged areas. With repeated sampling, we can also provide insight on changes in seasonal and temporal post-dredging prey availability.

Keywords: food webs, fish habitat, subtidal habitat, macroinvertebrates, benthos, dredging

Poster Topic Species and Communities

Phenotypic Plasticity and Morphological Variation in a Native Submerged Aquatic Plant

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Morphological variations in widely distributed plants may be driven by phenotypic plasticity or by underlying genetic differences. In the brackish open water region of the San Francisco Estuary (SFE), a population of sago pondweed, (*Stuckenia pectinata*) shows at least two distinct growth forms, which are so different that they were previously thought to be two species. This study confirmed the *S. pectinata* species identity for all morphologies through sequencing of the nuclear ribosomal internal transcribed spacer (ITS) region. I investigated phenotypic plasticity in response to flow variations in a common garden, and found that morphological traits are plastic but distinct morphotypes did not converge. I then used four microsatellite loci to investigate differentiation between the two morphotypes at three sites within Suisun Bay and the western Sacramento-San Joaquin Delta, and two populations from other central California sites for comparison. I found very few multilocus genotypes (unique combinations of alleles across two or more loci), which could be a reflection of low levels of clonal diversity, or a byproduct of low resolution in my methods. Lastly, I investigated the influence of plant morphology on the ecologically important invertebrate epibiont community. I found a positive relationship of plant surface area, leaf count, and leaf density with invertebrate abundance only at the more saline of the two sites sampled, which had a different invertebrate assemblage than the fresher site. Results of this study suggest that the two growth forms may provide different ecosystem functions and services, which could influence management and restoration decisions in the region.

Keywords: SAV, plasticity, pondweeds, microsatellites, morphology, invertebrate, epibiont, *stuckenia*

Poster Topic Species and Communities

Spatiotemporal Characterization of Microbial Communities Controlling Estuarine Nitrogen Cycling in the San Francisco Bay-Delta

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Nitrogen (N) availability is an important factor controlling productivity in estuaries. Yet, little is known about how environmental changes affect the diversity, abundance, distribution, and activity of N-cycling microbes. Using deep 16S rRNA and metagenomic sequencing through the Joint Genome Institute (JGI), we are investigating the structure and function of nitrogen and carbon cycling communities in San Francisco Bay, which receives high anthropogenic N input. Water samples span the estuarine gradient, from high-nutrient riverine regions to brackish transition zones to marine regions, and were collected during monthly USGS water quality monitoring cruises. Through JGI, we have assembled 88 16S rRNA amplicon libraries from bottom water samples collected approximately monthly from April 2013 to March 2014. By coupling genomic approaches with environmental data collected by USGS, we hope to gain insights into how environmental factors impact microbial communities and specific biogeochemical processes in the water column. We are particularly interested in nitrification, an important process linking decomposition of organic N to anaerobic "nitrogen loss" processes. Previous work in our laboratory has characterized nitrification functional genes (e.g., amoA) and biogeochemical rates from many of these samples, facilitating comparisons between 16S rRNA diversity and relative abundances to functional gene abundance and metabolic rates. We also seek to elucidate positive and negative co-occurrence between N-cycling taxa using network analysis.

Student Award Competition: Yes

Keywords: geomicrobiology, nitrification, thaumarchaea, ecology, nitrogen

Poster Topic Species and Communities

Seasonal and Spatial Patterns of Macroalgal Dominance in San Francisco Bay Eelgrass (*Zostera marina*) Beds

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Eelgrass (*Zostera marina*) beds in San Francisco (SF) Bay provide habitat for invertebrates and support the refuge needs or food webs of resident and migratory fish and birds. Benthic macroalgae and epiphytes (algae attached to eelgrass leaves) in eelgrass beds also provide habitat and food but can compete with the eelgrass for light and nutrients. Over several years of monitoring SF Bay eelgrass beds, we had observed high abundances of algae at times, but these primary producers had not been quantified; hence, we had no basis for understanding their values or potential for harm to eelgrass. We assessed abundance and composition of algae in four eelgrass beds during six sampling events over two years. We found a highly variable mosaic of species and large seasonal and spatial fluctuations in biomass (two to four-fold). In addition, we found that at certain locations and seasons, macroalgae reaches abundances documented in other regions as detrimental to eelgrass. However, we posit that these high abundances of palatable algae, as well as the numerous invertebrates present on or within the algal mats, play an important role in energy transfer to higher trophic levels. We conclude that eelgrass does not always contribute the most biomass or physical structure within eelgrass beds, and suggest that previously undocumented high abundances of macroalgae warrant further study in order to understand the full picture of primary production and trophic transfer within these beds, as well as potential impacts to eelgrass.

Keywords: eelgrass, *Zostera marina*, macroalgae, San Francisco Bay, primary producer

Poster Topic Species and Communities

A Spatiotemporal Assessment of Benthic Community Composition in a San Francisco Bay Mudflat

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Most benthic organisms are limited in mobility and thus cannot easily relocate to more suitable habitats. As such, benthic communities are excellent indicators of environmental change. With widespread restoration efforts and sea-level rise concerns throughout San Francisco Bay, identifying the most important environmental drivers of benthic community variation in this region is timely. This study provides an in-depth analysis of an extensive benthic dataset collected from a subtidal shoal in the South Bay. Benthic community-habitat relationships were evaluated using a combination of multivariate regression tree (MRT) and redundancy analysis (RDA) to determine the extent to which temporal (sampling month and year) and environmental factors (distance from shore, inundation, sediment chemistry, sediment grain size, and chlorophyll *a*) explain community composition in this region. Of the environmental variables examined, distance from shore and inundation explained the largest proportion of the community variation (34.0 and 21.8% in RDA, respectively). Yet, there were no temporal effects on community composition observed. In this study, the community-habitat relationships appear to be robust to temporal variation, but factors associated with distance from shore, including inundation, will be directly impacted by sea-level rise. Thus, future efforts that evaluate the extent to which communities respond and adapt to sea-level rise could be valuable. Results of this study will provide important information about benthic community-habitat relationships that can potentially have bottom-up implications for higher trophic foragers, such as waterbirds and benthic foraging fishes.

Keywords: food webs, multivariate analysis, macroinvertebrate communities, benthos, sea-level rise

Poster Topic Species and Communities

Deep in the Shallows: Environmental Variability and Habitat Use by Native and Invasive Fishes in San Francisco's Complex Saltmarsh Complexes

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Coastal salt marshes and wetlands are among the most productive, economically important and threatened aquatic habitats worldwide. Degradation of these ecosystems results in the loss of numerous ecosystem functions and alters the suitability of habitats for native fishes, often favoring invasion by non-native species. To improve function and suitability for native species, large-scale restoration of salt marsh habitats has become a top priority nation-wide, especially in the San Francisco Estuary (SFE). The SFE is the largest estuary on the west coast of the United States, and with 7 million people along its shores, the SFE has experienced myriad perturbations including loss of wetland habitats, reduced freshwater flows, suspended sediments and primary production, elevated nutrient loading, and invasion by alien species; together, these impacts have dramatically altered the functioning of the Estuary. Though previously viewed as resilient to such impacts, recent changes including harmful algal blooms and declines in the abundance of fishes suggest the system is becoming increasingly degraded and in need of on-going restoration efforts. However, limited data exist on the physical attributes and biological communities in the SFE's marsh complexes and how these vary spatially, seasonally, and among years. Without high-quality physical and biological baselines, it will be impossible to assess the efficacy of our restoration and other conservation efforts. Here we examined variation in habitat quality and use by fish communities in several marsh complexes throughout northern and southern regions of the SFE, including several restored salt marsh habitats. These surveys have allowed us to describe spatial variation (among and within marsh complexes) and temporal patterns (among seasons and years) in habitat suitability and utilization by native and invasive fishes in the SFE.

Keywords: marsh, invasive, restoration, estuary

Poster Topic Species and Communities - Fish

Examining the Diets of Longfin Smelt Larvae in Shoals and Tidal Marshes of the San Francisco Estuary

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The San Francisco Estuary is one of the most altered ecosystems in the world. Longfin smelt were historically one of the most abundant native fish species in the San Francisco Estuary, but population abundance has declined by over an order of magnitude in the last two-three decades. Decreases in zooplankton abundance, or food availability, is one main reason for the species' decline. Shoals and tidal marshes are important rearing habitat for larval and juvenile longfin smelt and until recently use of these habitats by longfin smelt has been neglected. Do these areas provide high-quality habitat for longfin smelt? To answer this question, I sampled larval fish and zooplankton concurrently in 2016 and 2017 in shoals, tidal marshes, and channels in the brackish northern estuary. Gut content analysis and identification of zooplankton species composition in the environment will show if the sampling sites are productive food sources for longfin smelt larvae. I will compare variations in food availability among different environmental conditions, sampling sites, regions, and years to help determine the factors that predict longfin smelt distribution in relation to food availability. If shoals and tidal marshes provide high-quality habitat for longfin smelt, restoration could be focused on these areas to promote recovery of the species.

Student Award Competition: Yes

Keywords: longfin smelt, zooplankton, tidal marsh, shoal, diet

Poster Topic Species and Communities - Fish

Effects of High Temperature and Low Oxygen on Early Life Stage Chinook Salmon Physiology

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Climate change and drought can lead to increased temperature and decreased dissolved oxygen in rivers. In the Central Valley, rivers are typically managed for salmonid survival based on temperature; however, oxygen saturation is another critical factor for managers to consider. Salmon embryos are particularly susceptible to high temperatures and low oxygen given that conditions within a redd, or nest, can differ from those of the river itself. To investigate how temperature and oxygen as single and combined stressors affect the survival and physiology of early life stage Chinook salmon, we reared embryos from fertilization to the fry stage under low temperature and high oxygen, low temperature and low oxygen, high temperature and high oxygen, and high temperature and low oxygen. Fish were sampled at four stages during development to test their upper thermal tolerance and low oxygen tolerance, measure growth, and analyze biochemical responses. Fish reared in low temperature or low oxygen developed more slowly than those in high temperature or full oxygen. Embryos reared in low oxygen had reduced hatching success and the multiple stressor treatment with high temperature and low oxygen had greatly reduced hatching success. Acclimation to warm temperature or low oxygen increased upper thermal tolerance. Acclimation to low oxygen during development increased tolerance to low oxygen, while high temperature acclimation reduced low oxygen tolerance. These results demonstrate the importance of water management strategies that consider other abiotic stressors in addition to temperature to promote survival of early life stage Chinook salmon in the Central Valley.

Student Award Competition: Yes

Keywords: Salmon, climate change, physiology

Poster Topic Species and Communities - Fish

Effects of Temperature and Bifenthrin on the Endocrinology of Juvenile Chinook Salmon (*Oncorhynchus tshawystscha*)

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The San Francisco Bay-Delta is experiencing seasonally warmer waters and salt water intrusion into historically freshwater ecosystems due to climate change. Juvenile endangered Chinook salmon (*Oncorhynchus tshawytscha*) inhabit affected waterways from juvenile development through smoltification (or saltwater acclimation). Runoff events cause surface water contamination with pyrethroid pesticides, in particular bifenthrin, in Bay-Delta waterways. Thus, juvenile fish may experience increased seasonal temperatures during runoff events, and the effect of these warmer temperatures and bifenthrin exposure on pre-smolt Chinook are unknown. To increase our understanding of the potential interaction between temperature and bifenthrin exposure on early salmonid development, juvenile alevin and fry were reared within 11^0C, 16.4^0C and 19^0C fresh water for 11 days and two weeks, respectively, and exposed to 0, 0.15, and 1.5 μg/L bifenthrin for the final 96 hours of rearing. Estradiol-17β (E2), testosterone, cortisol, triiodothyronine (T_3), thyroxine (T_4) levels were measured in whole-fish homogenates using hormone-specific ELISAs. Gill Na+/K+ ATPase, brain gonadotropin-releasing hormone receptor (GnRH2), and brain growth hormone receptor (GHR1) mRNA levels were measured using qPCR. Results show significantly decreased survival and lower condition factors (indicator of fish health) in both juvenile stages with increasing temperature. Fry exposed to 1.5 μg/L bifenthrin had lower condition factors for all temperature exposures, indicating overall reduction in health. Additionally, alevin thyroid hormones were significantly increased with temperature, but fry thyroid hormones were altered with both temperature and bifenthrin. There were significant reductions in fry testosterone and E2 at the lowest temperature with increasing bifenthrin treatments, as well as significant changes in GnRH2 and GHR1 gene expression both alevin and fry. This research highlights the different impacts of temperature and bifenthrin to each juvenile stage due to targeted developmental time points. This material is based upon work supported by the Delta Stewardship Council Delta Science Program.

Student Award Competition: Yes

Keywords: Salmonids, Climate Change, Smoltification, Bifenthrin, Endocrine Disruption

Poster Topic Species and Communities - Fish

A Combined Biomarker and Metagenomic Study of Copepod Diet Across a Spectrum of Food Qualities

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Detrital carbon from wetland plants in the Sacramento-San Joaquin Delta (the Delta) is expected to rise as open water is converted to tidal marshland through restoration efforts, affecting food resources for the lower aquatic food web. While it is clear that primary production is a nutritionally-preferred food source for zooplankters, there are conflicting views as to how much detrital carbon can be incorporated into copepod diets and under what conditions. In order to understand the extent that terrestrially-derived carbon can be consumed by copepods, we iteratively introduced and removed discrete cohorts of *Eurytemora affinis* into Delta field water and monitored feeding as biolabile particulates were consumed, leaving less-preferred (presumably non-algal) particulates. The goal was to simulate a feeding environment reflective of the Delta under phytoplankton-limited, low quality feeding conditions. Water chemistry and copepod gut content were monitored during each iteration using a combination of chemical biomarkers and DNA amplicon metagenomics. Our results provide a survey of copepod diet across a spectrum of food qualities and clarify the role of non-algal particles in zooplankton diet.

Student Award Competition: Yes

Keywords: copepod, food web, diet, detrital, non-algal, iterative

Poster Topic Species and Communities - Fish

Revealing the Invisible Contributors to the Diets of Young Longfin Smelt in the San Francisco Estuary

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Pelagic fishes of the upper San Francisco Estuary have declined in recent decades due in part to a concomitant reduction in known food resources. Traditional methods to identify prey in the guts of local fishes are largely based on the morphological identification of prey, which are often partially digested, limiting the resolution of our view of important food web interactions. I am using a high-throughput DNA-sequencing analysis of larval and juvenile longfin smelt guts to describe the species composition of their prey in greater detail, greater taxonomic resolution, and with better detection methods than were previously possible. In addition to gut-contents, bulk prey community sequencing will allow comparison of the prey assemblage found in the guts to that in the water column to evaluate whether the fishes select certain prey from the available community. Complementary research by SFSU student Jillian Burns on the diet using morphological methods will allow comparison of genetic techniques with morphological methods, and fill holes in our knowledge of whether there are other prey items important in young longfin smelt diets that are not characterized through traditional methods. Here I present an overview of the research plan, and preliminary results on the diversity of potential prey in the zooplankton community. This work will provide insights into actions that could be taken to provide better support for local fish populations across the San Francisco Estuary through a better understanding of currently "invisible" links in the food web.

Keywords: Longfin smelt, diet, DNA, gut contents, juvenile, larval, zooplankton

Poster Topic Species and Communities - Fish

Rearing Habitat of Pacific Herring in the San Pablo and Suisun Bays

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Pacific herring (*Clupea pallasii*) are a commercially important anadromous fish that spawn in the San Francisco Bay estuary system. We performed larval surveys to identify potential spawning and nursery habitats for Pacific herring in the San Francisco Bay; which is the largest spawning population in California. Herring spawn *en masse* from November to March in the central bay on submerged vegetation and rocks in the subtidal and intertidal zones. Although spawning events are commonly observed in the central bay, there has been little research into spawning locations and habitat use by early life stage herring in northern San Pablo Bay and Suisun Bay.

Herring spawns occur mainly in the central bay, although conditions conducive to spawning exist throughout the estuary. This research provides evidence for herring spawning or rearing outside of the known central bay spawning regions. Surveys performed by ICF and the California Department of Fish and Wildlife have identified herring larvae during the spawning season throughout northern estuary.

We examined data from the CDFW 20mm Survey and the Bay Study Larval Survey. Larval pacific herring commonly occurred in both studies, although neither was optimized to sample herring spawning or rearing locations. Surveys performed by ICF identified herring in marshes and shoals well north of the central bay, and large concentrations of larval herring have been observed in the Napa and Petaluma rivers. Temperature and salinity have been shown to influence spawning location and hatching success, so herring larvae observed during these studies were modeled against environmental variables over multiple water years. Larval concentrations have nonlinear relationships with both salinity and temperature, suggesting that herring are hatching in or migrating to preferred habitat.

Keywords: Herring, Fisheries, Spawning, Nursery habitat, Anadromous

Poster Topic Species and Communities - Fish

Illuminating Endocrine Disruption: Determining Estrogenic Effects of Bifenthrin on Zebrafish Using Fluorescence

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Bifenthrin is a commonly used pyrethroid insecticide, and is frequently found in the San Francisco Bay Delta (SFBD). A known endocrine disrupting compound, bifenthrin has been shown to have estrogenic effects in fish, eliciting increases in plasma 17-β-estradiol (E2) and upregulation of genes downstream of estrogen receptors (ER) including *vitellogenin*, and *choriogenin.* Because bifenthrin has been shown in cell culture to bind to and activate estrogen receptors, and elicit estrogenic responses *in vivo*, it has been assumed that bifenthrin acts as an ER agonist *in vivo*. However, due to the presence of endogenously produced estrogen confounding a primary vs. secondary effect, the direct activation of ER by bifenthrin has yet to be shown *in vivo*. It is also possible that additional targets along the hypothalamic-pituitary-gonadal (HPG) axis are affected independently of estrogen receptor activation. Thus, the goal of this project is to 1) determine *in vivo* if bifenthrin directly activates estrogen receptors in the absence of endogenously produced estrogen, and 2) define alternative targets of bifenthrin within the hypothalamic-pituitary-gonadal axis. To evaluate the mechanism of endocrine disruption, zebrafish loss-of-function mutants coupled with a transgenic estrogen receptor-activation reporter line were used. Null mutants for *cyp19a1a*, an aromatase responsible for endogenous estrogen production, and a transgenic estrogen receptor reporter (5xERE:egfp) fish were exposed to bifenthrin during development, and evaluated for fluorescence. Bifenthrin was found to activate the transgene at high concentrations, and is currently being investigated at concentrations relevant to the SFBD environment. Gene expression for estrogen receptor subtypes and genes along the HPG axis will also be evaluated via quantitative polymerase chain reaction (qPCR). Using zebrafish as a model species, the results will reveal valuable knowledge of endocrine disruption mechanism applicable to wild fish populations and humans at risk from exposure to this commonly used insecticide.

Student Award Competition: Yes

Keywords: bifenthrin, endocrine disrupting compounds, estrogenic, zebrafish

Poster Topic Species and Communities - Fish

Initial Identification of Individual Cultured and Wild Adult Delta Smelt Using Natural Tags

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Given the need for effective tagging methods to identify individual Delta Smelt, we evaluated the use of external pigmentation as natural tags for this species using the dorsal view head area (DHA) because of its rich and variable pigmentation. We evaluated natural tags using cultured adult fish produced at the Fish Conservation and Culture Lab and conducted preliminary tests of natural tags on wild Delta Smelt photographed in the Sacramento-San Joaquin Delta by the Lodi Fish and Wildlife Office in January-February 2016. We tagged cultured fish with an individual alphanumeric code to verify the effectiveness of natural tags. Three photo sessions were conducted on cultured fish (October-April 2014-15), with each session including low and high light treatments to evaluate the influence of light on natural marks. We used 22 wild fish to compare the percent matching between two groups of replicate photos with variable resolution. A digital camera was used to acquire DHA and natural tags were evaluated using visual tests (naked eye) and automated image recognition (TinEye's Match Engine API). Cultured fish showed higher percent matching in visual tests (70-100 %) than in automated tests (19-33 %). Wild fish had fewer and smaller pigments compared to cultured fish and TinEye produced up to 88% match without mistakenly matching any of the remaining fish. Pigmentation in cultured fish was generally less apparent under the high light treatment but it did not result in significantly different percent of matching using either visual or automated matching. The percent matching could be improved by using a lens with vibration reduction, fully submerging fish in water when taking photos, and consistently acquiring high resolution photos. These preliminary results indicate further standardization of photo acquisition and development of automated matching methods is needed to more fully evaluate the effectiveness natural tags in Delta Smelt.

Keywords: Delta Smelt, natural tags, wild fish, cultured fish, pigmentation

Poster Topic Species and Communities - Fish

The Timing and Distribution of Juvenile Lamprey in the San Francisco Estuary

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The Central Valley is home to both River (*Lampetra ayresi*) and Pacific lamprey (*Lampetra tridentata*). Considering the Central Valley rivers are severely truncated by dams, lamprey ammocoetes likely occupy habitats lower in the watershed than historically documented in undammed coastal streams and rivers. In this study we aim to describe freshwater ammocoete distribution, which has likely been greatly altered by human use. While habitat preference for ammocete lampreys remains largely unknown, we believe ammocetes remain in freshwater tidal habitats as well as streams during their sedentary phase while they filter feed and metamorphose over the course of several years. An additional complication is the lack of targeted monitoring for lamprey in this system. Here, we summarize available data on lamprey, from an assortment of long-term monitoring programs, and use occupancy modeling to better understand lamprey distribution. We found many inconsistencies in the documentation of lamprey, for example, species could be misidentified in many monitoring efforts, and in some cases simple descriptive information (e.g. length, number) is not recorded. Many changes to the estuary could impact lamprey (e.g. dredging of the shipping channel, invasion of non-native clams) but currently there is no targeted effort to understand how lamprey use benthic habitats in the estuary. This study could be used to better manage these understudied species and reduce the human impact on native fish.

Keywords: lamprey, ammocoete, distribution, occupancy, benthic, native fish, conservation, resource management,

Poster Topic Species and Communities - Fish

Growth, Survival, and Tag Retention of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) Surgically Implanted with a Dummy Acoustic Transmitter

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Surgically implanted acoustic transmitters are widely used for survival studies of salmonid species. Many studies have been conducted to determine the influence of tag burden on various aspects of fish health. However, there are few studies conducted with the smallest tags available (0.3 g in air) implanted into fish as small as 6.0 g, resulting in a tag burden up to 5%. The objective of this study was to assess the influence of tag implantation and tag burden on survival, growth rate, tag retention, and healing in juvenile Chinook Salmon weighing 7.8 ± 0.9 g (mean ± SD). Hatchery-raised fish were surgically implanted with a JSATS dummy acoustic transponder, tagged with a visible implant alpha tag, and held for 30 d. Control fish were also tagged with a visible implant alpha tag and held in the same tank as dummy-tagged fish for the same duration. All fish were euthanized and necropsies were performed at the conclusion of the holding period. There were no significant differences in survival or the health parameters assessed between control and dummy-tagged fish. However, dummy-tagged fish grew significantly slower than control fish. Further analysis revealed no significant relationship between tag burden and specific growth rate of dummy-tagged fish, indicating the presence of the tag alone and not the size of the tag compared to the body weight resulted in decreased growth. These results are important for survival studies where inferences are made to wild populations of fishes based on data obtained from fish with surgically implanted acoustic tags. Size is often linked to survival of wild fishes, so it may be possible to develop a correction factor for tagged versus untagged fish based on reduced growth if a relationship between size and survival is developed.

Keywords: Chinook, *Oncorhynchus tshawytscha*, tag retention, JSATS, tag effect, survival, telemetry

Poster Topic Species and Communities - Fish

A Tale of Two Stripers: The Benefits of Using Multiple Fish Tracking Technologies

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Understanding predatory fish behavior within the San Francisco Bay and the Sacramento-San Joaquin Delta (Delta) is important for conserving listed fish species and informing fisheries management practices. Currently, the California Department of Water Resources (DWR) is using a variety of fish-tracking technologies for the Clifton Court Forebay Predation Study to evaluate the behavior of predatory fish at the intake to the State Water Project. DWR used acoustic tags, passive integrated transponder (PIT) tags, and visual external tags to mark multiple species of non-native predatory fish in the Clifton Court Forebay (Forebay). These tagged fish have been detected by multiple methods, including acoustic receivers, PIT antennas, and physical recapture. Here we present the movement patterns and emigration from the Forebay of two individual tagged fish (Striped Bass; *Morone saxatilis*). The two Striped Bass were later captured by anglers in the San Francisco Bay. Had these fish not been recaptured and identified by their external tags, we would not have gathered data on their migration to the San Francisco Bay months after their last detections in the Forebay. Additional information gained from angler recaptures illustrates the benefits of dual tagging to achieve a more accurate understanding of fish behavior.

Keywords: Dual Tagging, Biotelemetry, Fish Tracking, Predator Behavior

Poster Topic Species and Communities - Fish

Thermal Resilience of Delta Smelt: What Can We Learn from Otoliths?

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The Sacramento-San Joaquin Bay-Delta forms a vital link in California's water supply and is managed for both human use as well as for several species of threatened and endangered fish, causing significant conflict over limited freshwater resources. The endangered Delta Smelt (*Hypomesus transpacificus*) is at the center of this conflict and its abundance levels are at an all-time low. Generally, high freshwater outflow years provide benefits for many estuarine species, including Delta Smelt. However, not all high outflow years produce higher abundance for Delta Smelt, indicating that other factors may be limiting abundance and complicating predictions of the effects of freshwater outflow management.

Otoliths (tiny bones in the inner ear of fish) provide a life-long archive of physiological and environmental conditions that a fish has experienced. Studies using otoliths in combination with extensive monitoring surveys have shown that Delta Smelt exhibit a diverse life history termed partial migration, which includes migratory, freshwater resident, and brackish-water phenotypes. Historically, this has allowed Delta Smelt to persist in the dynamic habitat of the Delta by spreading the risk of catastrophic mortality between multiple habitats. Here we use oxygen isotope ratios ($\delta^{18}O$) from archived, wild-caught Delta Smelt otoliths to reconstruct their thermal life history. As a first step, we calibrate the $\delta^{18}O$ temperature-dependent fractionation and validate the reconstruction of ambient water temperature from otolith $\delta^{18}O$ using Delta Smelt from lab experiments carried out at UC Davis. This tool will allow us to investigate the relationship between Delta Smelt abundance and water temperature. Understanding this relationship can give new insights into resilience and habitat utilization of Delta Smelt in the face of warming water temperatures during extensive drought periods and long-term climate change, which in turn will allow state agencies to better manage the limited water resources of California for both fish and people.

Keywords: Delta Smelt, Otoliths, Isotopes, Thermal resilience, Drought

Poster Topic Species and Communities - Fish

Performance of a Mass Marking Technique, SE-Mark™ (Calcein), on Post-Larval Longfin Smelt (*Spirinchus thaleichthys*)

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We tested the performance of a SE-MARK (calcein) for marking Longfin Smelt (LFS), a state-listed, threatened species, for potential use in mark-recapture experiments. Calcein is a non-toxic, fluorochrome [chemical] that can be used in live finfish. Calcein-marked tissue is easily visible when viewed under 495/500 nm wavelength light.

Post-larval LFS (mean fork length= 33 mm) produced from wild brood fish were spawned and reared at the UC Davis Fish Conservation and Culture Laboratory (FCCL). A 125mg/L bath mixture of calcein and source water was prepared and the post-larval LFS were exposed to the bath for 1 hour. Mark retention was monitored and scored immediately following calcein exposure and at intervals up to 90 days post-marking. Due to the sensitive nature of the test organism, only deceased subjects were evaluated for mark retention. Immediate and 24 hour mortality in marked groups were compared with control groups to determine if excess mortality occurred as a result of calcein exposure. Marks were graded or scored according to the U.S. Fish and Wildlife Service's Investigational New Animal Drug (INAD) program protocols. Easily visible marks were observed and the mark method shows promise for use in LFS. However, larval LFS rearing and mortality were highly variable, ranging from 0% - 45%. Therefore, before calcein can be used for mass marking with this species, the rearing methods need further research and improvement.

Keywords:

Poster Topic Species and Communities - Sensitive Species

A Comprehensive Protocol for Monitoring Ridgway's Rail Population Trends in the San Francisco Estuary

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The California Ridgway's Rail, found throughout the San Francisco Estuary, is a federally-listed endangered species requiring effective monitoring to support its recovery, alongside tidal marsh restoration and enhancement efforts. Unfortunately, because of different survey methods, biologists are not able to easily extract information on population trends, management actions, or response to restoration. Additionally, variance is introduced by the use of disparate survey methods and the results may not be reliable. Broadcasting marsh bird vocalizations has been shown to generally increase detection probability for most marsh bird species. The Standardized North American Marsh Bird Monitoring Protocol has been adopted by many federal, state and local organizations across the U.S. Using the National protocol as a framework, Point Blue Conservation Science in partnership with the USFWS, pursued the identification and promotion of an efficient method for surveying and analyzing secretive marsh bird populations throughout the Estuary, employing the broadcast of two species, Ridgway's and Black Rail. In order to maintain consistency, and to ensure no biases with the previous 11-year dataset, a pilot study was initially conducted. By pairing survey protocols and using appropriate statistical methods, it was determined that the switch to a call broadcast protocol could be accounted for in the data. This site-specific protocol was implemented by the USFWS, Point Blue, and other partners for the 2017 season. Coordination among partners, including appropriate statistical analysis and reporting, as outlined in the protocol, is essential for monitoring and recovery of the rail population. As marsh restoration moves forward, successful adaptive management actions must account for rail population responses, which can be best analyzed annually from a centralized, standardized monitoring data management system, as implemented with the Site-specific Protocol for Monitoring Marsh Birds in San Francisco Bay.

Keywords: Ridgway's Rail, sensitive species, tidal marsh restoration, monitoring, protocol

Poster Topic Species and Communities - Sensitive Species

Biogeography and Habitat Dynamics of Bank Swallows on the Sacramento River

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The Sacramento River corridor provides nesting habitat for the largest documented meta-population of breeding Bank Swallows in California. The species depends specifically on river processes (erosion, deposition, channel migration) which renew its nesting substrate, steep riverbanks of friable soils, on a nearly annual basis. These river processes have been impacted by flow impairment from dams, disconnection of floodplains, and flood control measures such as bank stabilization, resulting in declines in the Bank Swallow population and other wildlife taxa. Several significant data gaps exist which impede progress on implementing habitat restoration for the species. While Bank Swallow population surveys have been conducted along the Sacramento River since 1986 by natural resource agencies, clear and quantitative identification and spatial mapping of suitable nesting substrate (e.g. soil characteristics) is lacking. Further, the efficacy of bank restoration in creating usable Bank Swallow habitat remains untested. Using a maximum entropy modeling approach, we describe the spatial variability of suitable soil characteristics using the location of Bank Swallow colonies along the Sacramento and Feather River. Further, we present empirical data on the response of Bank Swallows at locations where bank stabilization no longer persists. Given the importance of Sacramento River habitats in the context of other continental habitat resources and the large meta-population using these resources, Federal endangered species protections may be warranted. Bank restoration efforts aimed at addressing Bank Swallow recovery should consider soil characteristics and river meander potential. Entities focused on the broader implementation of environmental policy, river restoration, and environmental risk reduction benefit significantly from an improved understanding of Bank Swallow habitat and its relationship with riverine geomorphic process.

Student Award Competition: Yes

Keywords: riparian, riprap, species conservation

Poster Topic Species and Communities - Sensitive Species

Fitness of Cultured Delta Smelt in the Wild

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The fitness of cultured Delta Smelt in the wild has drawn more attention than ever before since there is an increased interest in their resilience due to the continued decline of wild Delta Smelt. The UC Davis Fish Conservation and Culture Laboratory conducted a study to look at the resilience of cultured Delta Smelt in an environment that mimics the wild. A total of 526 adult Delta Smelt (at 297 days post hatch) were released into a large trough (total volume of 12,870L with a cultural volume of 5,604L) with raw water pumped from the California Aqueduct located at the end of Clifton Court Forebay. The fish not only experienced natural water conditions, but could also feed on any food available in the raw water. The trial started on December 5th, 2016, and their survival was 82% (88% if sampled fish excluded) on May 2nd, 2017, which was Day 148 of the study. The condition factor of fish dropped 0.26 for the first 98 days but bounced back to -0.04 on Day 140. This may have been caused by the various food types and their abundance in the water source. Gut content of fish was collected for further identification and analyses. As the water temperature increased, so did the mortality, especially at temperatures higher than 20°C. On June 20th, Day 197 of the study, a severe heat wave led to a water temperature higher than 27°C for several days, which caused a huge loss of fish and concluded the study. Fifteen fish survived at the end of the study, which was much less than the estimated survival (278) based on the corpses found. Predators found sneaking into the trough may have led to the low recovery rate.

Keywords: Delta Smelt, resilience, food, condition factor, temperature, predator

Poster Topic Species and Communities - Sensitive Species

Longfin Smelt Distribution: Abundance and Evidence of Spawning in San Francisco Bay Tributaries

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Historic Surveys conducted as part of monitoring programs have shown evidence suggesting Longfin Smelt may utilize tributaries in North Bay and South Bay as spawning and larval rearing habitat predominantly during high outflow years; however, the frequency and magnitude of the contribution of tributary spawning to adult abundance and year class strength is currently unknown. In January 2015, we began sampling tributaries to the San Francisco Bay Estuary to document the distribution and relative abundance of adults, larvae, and juvenile recruits. In four tributaries, (Napa River, Sonoma Creek, Petaluma River, and Coyote Creek) adults were sampled using an otter trawl monthly, while larvae were sampled using a replica of California Department of Fish and Wildlife's Smelt Larval Survey sled. In 2016 and 2017, we included the 20-mm net in the North Bay tributaries to document juvenile distribution and abundance. Larval and juvenile Longfin Smelt were found in low densities in the North Bay tributaries in 2015 and 2016, however; no larvae or juveniles were found in South Bay tributaries. In 2017 however, with a significant increase in fresh water input, larger numbers of Longfin Smelt were found in all North Bay tributaries, San Pablo Bay, Central Bay and juveniles were also found in South Bay tributaries. Adults have been more abundant in South Bay tributaries than the North Bay suggesting this area may operate as a sink to the population in drought periods. Larval life stages were found predominantly in lower salinity habitats than juveniles and adults, and few Longfin Smelt were found in the North Bay or South Bay when water temperatures exceeded 18 ºC. These data suggest Longfin Smelt spawned in North Bay tributaries during this drought period as well as during a wet year and at least some individuals are found outside of the existing monitoring range.

Student Award Competition: Yes

Keywords: Longfin Smelt, Restoration, Ecology, Larval Fish, Spawning Habitat

Poster Topic Species and Communities - Sensitive Species

Evaluation of Oyster Shell Enhancement on Western Snowy Plover Breeding Success

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The Pacific Coast population of the western snowy plover (*Charadrius nivosus nivosus*; plover) is listed as a federally threatened species under the U.S. Endangered Species Act. The population has experienced poor reproductive success as a result of anthropogenic habitat loss, fragmentation, and high predation pressure. Plovers in the South San Francisco Bay use dry salt evaporation ponds and wildlife-managed ponds to breed and winter. However, the South Bay Salt Pond Restoration Project aims to restore up to 6,110 hectares of this habitat back to native tidal marsh which will require plovers to breed in smaller areas and in higher densities. In order to recover this species in such unique conditions, remaining pond habitat can be enhanced using oyster shells which may provide camouflage for breeding plovers, thereby possibly decreasing predation. This study evaluated the effect of oyster shell enhancement on plover breeding success by comparing nesting density, nest success, and brood behavior between enhanced and non-enhanced areas. Plovers selected to nest in enhanced areas which created higher nesting densities compared to non-enhanced areas. However, nest success and survival over time did not increase with enhancement. Predation by common raven substantially limited nest success during study years, suggesting that enhancement may not effectively prevent nest predation by intelligent generalist species. Brood behavior was also affected by enhancement, though highly correlated with the location of optimal foraging habitat. It is likely that oyster shell enhancement will improve plover nesting success only if predator populations are concurrently controlled. Ultimately, plovers may benefit from the application of oyster shells as it attracts nesting effort, and may be strategically used by resource managers.

Keywords: plover, recovery, threatened, habitat enhancement, breeding, nesting, success

Poster Topic Species and Communities - Sensitive Species

Trees in Green Infrastructure: Their Health and Growth in Relation to "Soil" Conditions in Street-Side Bioswales

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Street-side stormwater management facilities ("bioswales") are an essential element of the stormwater infrastructure, and while most include small plants, many are also planted with trees. The growth and continued good health ("performance") of these trees is presumed, but has not been documented or evaluated, whereas the unique conditions of bioswale "soil" – a specific, rapid-draining soilless substrate – potentially present challenges to tree performance. This poster presents preliminary results (2015-2017) on bioswale substrate conditions (temperature and moisture, recorded by dataloggers) and tree growth and health from four Bay Area cities that installed bioswales from 2009 to 2013, and results from Portland (OR) are shown for comparison (from bioswales as old as 2000). No prolonged waterlogging was recorded in any of the Bay Area bioswales, whereas long dry periods during the summer were recorded in bioswales without functioning irrigation systems (contrasting with Portland, where some substrate moisture persisted throughout the summer). Tree growth in bioswales was generally slow, but comparable to those of trees in adjacent sidewalk planting strips. A notable preliminary finding is that the urban foresters' concern over waterlogging (in winter) was not confirmed by the data; instead, the issue of summer drying of the substrate may be more consequential in our Mediterranean climate (in contrast to Portland, OR).

Keywords: tree, bioswale, rain, garden, urban, forestry, arboriculture, soil, infiltration, carbon

Poster Topic Storm Water

Comparative Study of Consumptive Water Use in the Sacramento-San Joaquin Delta

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Understanding consumptive water use in the Sacramento-San Joaquin Delta is critical for resource management, water rights administration, and environmental and water quality protection. This study compares evapotranspiration (ET) estimates across the Delta by seven different methods for the 2015 and 2016 water years, along with direct ET measurement at field stations in selected crops. Participating research groups include DWR, USDA-ARS, ITRC Cal Poly-SLO, UC Davis, NASA-ARC, and CSU Monterey Bay. These methods use a variety of input data to estimate ET over multiple land use categories. Common input datasets were shared across methods when possible, and field measurements were made available for calibration and validation. Overall ET results for the Delta are consistent with water balance estimates in the California Water Plan, and all seven methods are within 10% of the mean estimate. Increased fallowing of land caused total ET to decrease from 2015 to 2016, with the majority coming from alfalfa, corn, and pasture crops. Field ET measurements in bare soil, alfalfa, corn, and pasture were lower than many ET estimates, suggesting that localized microclimates and wind patterns in the Delta may reduce consumptive water use compared to estimates based on remote sensing. The study provides additional discussion of methodological differences between methods. This study has important implications for water management in the Delta at multiple scales. Field-level ET estimates may eventually replace water use reporting and can be used to evaluate water transfers or natural vegetation restoration. Regional ET estimates may inform upcoming groundwater regulations and other hydrodynamic and water quality models. Delta-wide estimates will help inform long-term operations and planning. The resulting estimates and measurements of ET within the Delta, along with the knowledge of data uncertainties, can help water managers and stakeholders understand the impacts of land use changes on the estuary's ecosystem and human interests.

Student Award Competition: Yes

Keywords: Evapotranspiration, Modeling, Agriculture, Water, Vegetation, Delta, Policy, Planning, Comparison, ET

Poster Topic Water Management

Incidental Nitrogen Removal in a San Francisco Bay Wastewater Treatment Plant

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San Francisco Bay Area wastewater treatment plants are collectively facing and working to address nutrient pollution challenges in the San Francisco Estuary. Traditional plant upgrades for nutrient removal are millions of dollars in capital investments. Consequently, the City of Palo Alto Regional Water Quality Control Plant (RWQCP) evaluated options for increased nutrient removal by optimization of current treatment works. The RWQCP is a tertiary wastewater treatment plant containing primary sedimentation tanks, trickling filters, nitrifying-activated sludge, and dual-media filters. Current plant treatment works are designed to transform ammonia-nitrogen to nitrate-nitrogen, but not designed to remove nitrogen. A previous study indicated 40 percent of influent nitrogen was incidentally removed through the current treatment works. This study collected influent and effluent samples from pertinent processes throughout the plant to identify where the incidental total nitrogen removal was occurring and through which pathways. Data was used to evaluate where in the current treatment works nitrogen removal optimization efforts should be focused.

Keywords: Nitrogen, removal, treatment, wastewater, nutrients, estuary

Poster Topic Water Management

Investigating the Impacts of Freshwater Flow Pulses in the Yolo Bypass

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Copepods are key members of estuarine food webs, providing a trophic link between phytoplankton and larval and juvenile fish. Copepod growth rate is a useful measure of food limitation and secondary production. In the San Francisco Estuary copepods have been shown to have consistently lower growth rates than maximum laboratory growth rates. However, the Yolo Bypass floodplain of the northern San Francisco Estuary and adjacent waters have been shown to have growth rates that are close to maximum laboratory rates. The objective of this project is to investigate the impacts of freshwater flow pulses passed through the Yolo Bypass on phytoplankton composition and copepod growth. Copepod growth of the Yolo Bypass was determined for summer 2015 and 2016 using the artificial cohort method with image analysis to estimate mass per copepod. Our results indicate that growth rate is high in the Yolo Bypass and that it is weakly correlated to chlorophyll. This research will be helpful in determining whether freshwater flow pulses are an effective way to promote secondary production and thereby to enhance feeding opportunities for endangered planktivorous fishes.

Student Award Competition: Yes

Keywords: Copepod, growth rate, Yolo Bypass, *Pseudodiaptomus forbesi*, management

Poster Topic Water Management

Evapotranspiration from Three Crop Types in the Sacramento-San Joaquin River Delta

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Our research addresses the question, what is the consumptive water use of major crops in the Delta? Evapotranspiration (ETa) measurements were taken at 14 sites in 2016 and 2017 representing three major Delta crops: pasture, alfalfa, and maize (corn). Eddy covariance, eddy covariance with energy budget residual, and surface renewal with energy budget residual were used in this study. All methods converge on lower actual evapotranspiration rates than for using the typical crop coefficient-based estimates and the California Irrigation Management Information System-based reference ETo. Our results agree well with previous measurements in the Sacramento-San Joaquin River Delta for maize and alfalfa and also match the general concept of lower ETa values than predicted if using crop coefficients derived outside the SSJ Delta. The uncertainties between the three methods are analyzed and discussed, but these uncertainties are neither of high enough magnitude, nor exhibit sufficient mean bias, to attribute our lower ETa values' differences from conventional crop coefficients from non-Delta regions. Our research suggests crop coefficients for the Delta may be expected to be lower than non-Delta derived crop coefficients, and apparently the measured crop coefficients may vary depending on year. This information is important to water managers and other stakeholders considering water usage patterns in the Delta.

Keywords: Evapotranspiration, consumptive water use, crop coefficient, eddy-covariance, surface-renewal, micrometeorology

Poster Topic Water Management

From Rio Vista to the Golden Gate Bridge: Seasonal changes in DOM chemistry across a salinity gradient

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Dissolved organic matter (DOM) concentrations and compositions undergo significant transformation as water entering the Delta from the Sacramento River works its way into the San Francisco Bay Estuary and out into the Pacific Ocean under the Golden Gate Bridge. New sources from wetlands and primary production are countered by photochemical and microbial degradation/assimilation as well as physicochemical losses such as flocculation. We conducted transects from the Golden Gate Bridge to Rio Vista (with freshwater endmembers collected at Belden's Landing, Vernalis [San Joaquin River], and Garcia Park [Sacramento River]) during three different seasonal/flow regimes, December 2014 in the aftermath of a winter storm, June 2015 during summer low flow, and May 2016 during the spring freshet. Each transect was marked by distinctly different lignin compositions. The spring freshet had the highest average molecular weight, the highest diversity of compounds, and the highest aromaticity, as inferred from FT-ICR-MS data. Our dataset also includes amino acid, carbohydrate, UV-visible absorbance, and fluorescence data, and relationships between all these components will be explored in this poster.

Keywords:

Poster Topic Water Quality

Pollutant Removal Efficiency of Stormwater Biofilters

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Urban stormwater runoff contributes to flooding and impacts water quality with increased sediment and pollutant loads. Biofilters are vegetated filtration systems designed to mitigate stormwater by enhancing infiltration, sedimentation, contaminant sorption and uptake. Despite the rapid implementation of biofilters as stormwater management solutions, their performance is mainly evaluated in terms of flood reduction while their pollutant removal efficiency is rarely assessed. We investigated the effect of five California native plants (deer grass, sedge, rush, California rose, and blue sage) and four media additives (zeolite, compost, activated carbon, and rice hull biochar) on pollutant removal in test columns. Triplicate biofilters consisted of layers of pebbles, fine sand, filtration mix (coarse sand + local soil + additive), mulch, and plants. A synthetic mixture of nutrients, metals, and salts in proportions representative of stormwater composition was applied to the test columns. Biofilters oxygenated, neutralized, and decreased the turbidity of stormwater. They removed over 77% of dissolved copper, nickel, and zinc, even when applying synthetic runoff with metal concentrations three orders of magnitude larger than in actual stormwater. Lead removal was not as successful, ranging from 153% leaching from biofilters planted with California rose to 50% removal by rush-planted biofilters. Ammonium was generally removed from synthetic runoff (60-96%, exception: activated carbon, 40%), while nitrate was poorly retained (max. zeolite, 33%) or even leached from biofilters (controls without additives). This study demonstrated that with proper consideration of the filtration mixture and choice of native plants, biofiltration systems can effectively remediate urban stormwater.

Student Award Competition: Yes

Keywords: biofiltration, runoff, heavy metals, nutrients, phytoremediation

Poster Topic Water Quality

When It Rained, It Poured: Water-Quality and the End of the San Francisco Bay Drought

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From 2012 to 2016 California experienced severe drought, which caught national news attention. However, that drought ended abruptly with a series of storms that began in October 2016, continued through April 2017, and produced record-high precipitation and runoff. This natural experiment provided an opportunity to measure responses of San Francisco Bay, California's largest estuary, to hydrological extremes and place them in a long-term context. In 1968 the U.S. Geological Survey began a program of research and observation in San Francisco Bay that continues. The sampling program measures temperature, salinity, dissolved oxygen concentration, suspended particulate matter, chlorophyll-a, and nutrients along the estuarine salinity gradient. Large influxes of freshwater displace the salinity gradient seaward and change the distributions of these properties along the river-ocean continuum. Here we compare spatial distributions of estuarine properties from the peak drought period of 2016 and the anomalously wet spring of 2017 to highlight what we have learned about how the Bay responded to an abrupt end to an extreme drought.

Keywords: Water quality, drought, estuary, extremes, San Francisco Bay

Poster Topic Water Quality

A Hybrid Treatment System to Remove Contaminants from Reverse Osmosis Concentrate Produced by Potable Water Reuse Systems

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Bay Area water agencies are increasingly considering large investments in potable water reuse systems. Although reuse increases urban water security through the recovery of water from municipal wastewater effluent, these systems almost always involve reverse osmosis—a process that produces a reject stream containing high concentrations of nutrients, metals, and trace organic contaminants. Due to limited mixing and dilution, the discharge of this reverse osmosis concentrate presents new challenges for the implementation of potable water reuse projects in South San Francisco Bay. As part of an evaluation of concentrate management alternatives, a pilot-scale hybrid treatment system was installed at the Silicon Valley Advanced Water Purification Center. The pilot system consists of two open water unit process treatment cells, with and without an ozone pre-treatment. The ozonation step is intended to oxidize trace organic contaminants (e.g., pharmaceuticals) and partially degrade chelating agents that prevent removal of toxic metals. The treatment cells employ a combination of sunlight-driven photolysis and biological treatment by a thick mat of bacteria and algae to remove nutrients, metals, and trace organic contaminants that are not fully removed during ozonation. Laboratory studies conducted as part of the design process indicate that ozone pre-treatment alters biological activity in the treatment cells in a manner that may enhance denitrification rates and facilitate removal of residual organic contaminants. Results from the first phase of the pilot-scale study (which began in July 2017) will be presented along with results from the laboratory studies.

Student Award Competition: Yes

Keywords: water reuse, concentrate management, ozone, treatment cells

Poster Topic Water Quality

Plankton Communities and Water Quality in the Sacramento River and its Tributaries

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In the near future, the Sacramento Regional Wastewater Treatment Plant will upgrade its treatment process to include nitrification and denitrification (the EchoWater Project), significantly reducing the total dissolved nitrogen concentration in its effluent. The research presented here provides a baseline of conditions, including water quality, turbidity, plankton community composition and biomass, and clam abundances, upstream and downstream of the effluent discharge into the Sacramento River for comparison to conditions after the EchoWater Project comes online. The baseline was assessed in two different seasons, May and October 2016, by sampling 16 stations between river mile 95 (upstream of Knights Landing) and river mile 19 (Isleton). Of the 16 stations, 11 were on the mainstem Sacramento River and five were at the mouths of tributaries along this reach. With respect to phytoplankton, a consistent decrease in biomass of 0.2 µg chlorophyll a L^{-1} per river mile was observed from river mile 95 to river mile 41 in spring, starting from a concentration of 14 µg chlorophyll a L^{-1}. In fall, the starting chlorophyll a concentration upstream was five-fold lower and the subsequent down-river decrease was smaller. In both seasons, phytoplankton biomass was dominated by diatoms. With respect to zooplankton, there was no consistent pattern along the mainstem but in both seasons biomass was highest in two tributaries located furthest upstream. The dominant zooplankters in those two tributaries were cladocerans such as *Bosmina* sp. The invasive Asian clam *Corbicula fluminea* was present at all mainstem sites sampled, but was relatively abundant at only two sites, river mile 70 and river mile 63. At these two sites, clams may have been capable of turning over up to 50% of the water column per day. Potential drivers, including nutrient concentrations, light availability, water flow affecting phytoplankton distribution, zooplankton, and clam biomass are discussed.

Keywords: Phytoplankton, water quality, wastewater treatment, nutrients, light availability, zooplankton, clams

Poster Topic Water Quality

Primary Productivity and Nutrient Uptake Rates in South Bay Measured During Spring 2016

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Monitoring of nutrients and phytoplankton biomass has been carried out regularly by USGS along the deeper central channel that runs along the longitudinal axis from Calaveras Point to Bay Bridge. However there are few reported measured rates of phytoplankton nutrient uptake or primary productivity and limited water quality data available for the shallower shoal regions. We conducted four weekly cruises, from April to May 2016 to answer the question "how do phytoplankton biomass and phytoplankton productivity and nutrient uptake rates vary spatially in South Bay?" Sampling was made at twelve stations that included three cross-bay transects (each with four stations) at Redwwood Creek (USGS-30), San Francisco Airport (USGS -27) and Candlestick Park (USGS-24) to include shoals on both the East Bay and South Bay shores. Underway mapping runs of temperature, salinity, nitrate using a SUNA nitrate sensor, chlorophyll fluorescence with a YSI EXO2 and quantum yield with a Phytoflash – in continuous mode using the onboard flow through system of the R/V Questuary. Discrete water samples were made at stations following a vertical profile for nutrient, chlorophyll and total suspended solids analyses and for incubations with tracer stable isotopes 13C-bicarbonate, 15-N-nitrate and 15N-ammonium. P vs I and uptake versus I incubations were also made to look at light dependency of the rates. Higher chlorophyll concentrations were observed in the shoals in the East Bay shore, and were correlated with high nitrate uptake and f-ratios. Data such as these are needed for ecosystem model development of the South Bay, where the importance of shoals has been modeled but not tested empirically.

Keywords: phytoplankton, productivity, nutrient, South Bay

Poster Topic Water Quality

Delta Environmental Data to Understand a California Estuary (DEDUCE): An Estuary-Wide Data Repository

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The Sacramento-San Joaquin Delta (Delta) has some of the most pressing water supply and natural resource management issues facing California. To navigate such matters comprehensively with transparency and rigor, it is important to ensure broad dissemination of data to support the State's mandated reforms to the Delta's water resources and ecological management. An Environmental Data Summit held in 2014 created a new era in information management and knowledge discoveries, and shed light on challenges associated with the use of disparate datasets.

The Delta Environmental Data for the Understanding a California Estuary (DEDUCE), a collaborative project building upon the Data Summit vision, initiated a forum to integrate disparate data from multiple sources along with legacy data that are currently not in any of the State's data-sharing systems. DEDUCE expanded the existing infrastructure to house water quality data from the Delta to address management questions by identifying and collecting high-priority data according to rigorous business rules while mapping these data to a central system. This important step of harmonizing the data improves its interoperability and increases the access to and exchange of high-quality environmental data. DEDUCE facilitates the upload, aggregation, and display of data in tools such as those created under the auspices of the California Water Quality Monitoring Council, including EcoAtlas, My Water Quality Portals, and CD3: Contaminant Data Display and Download tool: a tool that accesses and visualizes data compliant to State standards.

DEDUCE collected and uploaded legacy toxic contaminant data to the estuary-wide data repository, and established design standards to exchange datasets with the California Environmental Data Exchange Network (CEDEN), a contributor to the US Environmental Protection Agency's Water Quality Exchange (WQX). This data integration effort liberated accurate, accessible, and synthesized data for scientists and decision-makers as a foundation to inform management actions with the best available science.

Keywords: data sharing, legacy data, data repository, Water Quality Exchange (WQX)

Poster Topic Water Quality

Evaluating Turbidity in the San Francisco Bay-Delta Utilizing NASA and ESA Earth Observations

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Water quality is a critical element of freshwater supply, particularly in times and areas of drought. Limited water resources can be further strained if water quality concerns are not effectively and efficiently addressed. While there are measures in place to protect human and environmental health from poor and risky water quality conditions, implementation of these measures are frequently reliant on physical water samples, fixed station data, both of which have gaps in spatial and temporal coverage of water quality conditions. This consideration is especially important in environments that are highly complex and heterogeneous such as the San Francisco Bay Delta, as well as in budget-constrained areas, or sites that are remote and are challenging to access. Remotely sensed information can help supplement existing data hubs in support of more informed water management practices and represent a wealth of information that has yet to be fully leveraged. In this poster, we evaluate the application of remote sensing-derived turbidity from two Earth observing satellites in the San Francisco Bay Delta and conduct comparisons with in situ / station turbidity data from CDEC and USGS Water Quality Stations.

Keywords:

Poster Topic Water Quality

Monitoring the Bay and Estuary with Landsat-8 and Sentinel-2

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Landsat-8 and Sentinel-2 are high spatial resolution (15-30 m) satellites providing visible imagery which can be used to monitor water quality in the San Francisco Bay and Estuary. We provide examples of product imagery (Chlorophyll, Turbidity, ...) using these satellites, and discuss the processing chain, including *in situ* measurements, used to calibrate and validate the product imagery. Working in collaboration with NASA's JPL, and with the support of MWD, we are working to provide maps of water quality products in near-real-time for use by MWD, as well as, other state and federal agencies to assist in monitoring and managing Bay and Estuary waters.

Keywords: Remote Sensing

Poster Topic Water Quality

Water Quality Conditions in the Sacramento-San Joaquin Delta and Suisun and San Pablo Bays Interactive Report

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Report to the State Water Resources Control Board in Accordance with Water Right Decision 1641

This web enabled interactive report and data tool summarizes and provides a platform to explore water monitoring and special studies conducted by the Environmental Monitoring Program (EMP) within the Sacramento-San Joaquin Delta and Suisun and San Pablo Bays. This monitoring is mandated by Water Right Decision 1641 (D-1641). The interactive report provides the most current monitoring data and access to all historical data and trends.

The development of 1641 Water Quality Report for the California My Water Quality Portals provides content and data access to the scientific community and the public. The platform creates a forum for collaborative management and data collection between agencies, QAQC routines, method review and documentation, extensive metadata development, a view of conditions at the time of data collection, species backgrounders, field photos, and much more. Monitoring programs (including the Interagency Ecological Program) will have access to data analysis tools to perform preliminary analysis on their own data as well as EMP data and have the ability to combine it with real time delta conditions (from WDL, CDEC, NWIS, CEDEN etc). When dealing with such a complex and dynamic system it is necessary to utilize the data to its fullest potential, which is possible through data sharing and near real-time data analysis.

Data in the applications includes: EMP Zooplankton, Phytoplankton, Benthic, Water Quality: Chlorophyll, Turbidity, Nitrogen, Temperature, Hydrologic Conditions: Outflow, Runoff, Water Year Classification, Outflow. Special Studies: Stockton Deep Water Ship Channel, Dissolved Oxygen, Suisun Bay

Keywords: water quality, data, zooplankton, benthic, hydrology, interactive report, decision support

Poster Topic Water Quality

Comparison of Phytoplankton Fate and Transport in the Cache Slough Complex during Fall Agricultural Drainage Periods Using a Particle Tracking Model

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The Yolo Bypass' large seasonal floodplain is hydrologically linked to the Cache Slough Complex (CSC) and has been identified as a significant source of phytoplankton biomass to the San Francisco Estuary during higher flow months of winter and spring. However, recent chlorophyll observations in the Lower Sacramento at Rio Vista indicate that fall agricultural drainage flow pulses through the Yolo Bypass can contribute to increased downstream phytoplankton biomass during other months of the year. In 2012 (wet year), a chlorophyll pulse was observed at Rio Vista given a net positive peak near 700 cfs at Lisbon Weir; no chlorophyll pulse was observed in 2014 (critical year) given a net positive peak flow near 230 cfs. We hypothesize that the magnitude and duration of fall agricultural drainage pulses in the Yolo Bypass are linked to the downstream fate and transport of phytoplankton biomass into the CSC and Lower Estuary. Here we use a tidal hydrodynamic model with a Lagrangian discrete parcels method (MIKE21FM - Particle Tracking Module) to describe fate and transport within the CSC of phytoplankton particles originating from the Yolo Bypass, during a fall flow pulse in 2012 and 2014. Modeling showed that depending on net positive peak Lisbon flow, tidal conditions, and diversions, particles moved laterally within the system primarily into Little Holland Tract and Liberty Island, or toward sources of loss. Tidal conditions also played a role in transporting particles lingering in Liberty Island toward Rio Vista, which may be indicative of potential for CSC-produced phytoplankton. These analyses of fall pulses in a range of recent years (collectively from 2011 – 2016) inform future monitoring programs and management scenarios in the Yolo Bypass aimed to sustain and improve Upper Estuary tidal habitats.

Keywords: phytoplankton, food web, particle tracking, modeling, hydrodynamics, tidal, habitat, management

Poster Topic Water Supplies and Instream Flows

Visualizing and Aggregating Intensive Datasets to Better Understand the Cumulative Effects of Positive and Negative Impacts

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This project visualized and aggregated large, intensive datasets with other data to facilitate a common understanding of the individual and cumulative effects of various activities on the landscape. The project goals were to summarize landscape-scale habitat metrics through customized views to help guide restoration project planning and better meet reporting needs; make these data available to a broad audience; and visualize intensive datasets relevant to scientific inquiry and decision-making in EcoAtlas.

This project supported the visualization of the CALVEG habitats and California Stream Condition Index (CSCI) data layers in EcoAtlas. While the California Aquatic Resource Inventory (CARI) is used as the base map to evaluate water quality improvement, CALVEG is the appropriate base map for evaluating wildlife habitat conservation. With the new CALVEG data layer, users are able to visualize CALVEG habitat types with links to CDFW's Wildlife Habitat Relationships (WHR) classifications, and summarize acres by habitat type for an area of interest. CSCI scores translate complex data about individual benthic macroinvertebrates living in a stream into an overall measure of stream health. With the new CSCI data layer, users are able to generate charts that show the distribution of CSCI scores for an area of interest using the Landscape Profile Tool and view the CSCI scores managed by SWAMP on a map along with other landscape-scale data layers.

There are numerous benefits to visualizing data that include increasing access to key information by displaying data in a dynamic, geospatial landscape context, and extending the value of data by visualizing and aggregating it with supplemental datasets. Data visualization facilitates a common understanding of the individual and cumulative effects of activities on the landscape, and aids in discovering trends and outliers that affect management actions to better guide monitoring and assessment.

Keywords: data visualization, landscape-scale, cumulative effects, decision-making tools

Poster Topic Watershed Management